SCIENCE EDUCATION

VOLUME 38 APRIL, 1954 NUMBER 3

SCIENCE EDUCATION

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The National Council on Elementary Science
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THE INSTITUTE FOR THE TEACHING OF CHEMISTRY

The fourth annual Summer Institute for the Teaching of Chemistry, sponsored by St. Louis University, will be held this year from June 21 to July 30.

Organized in 1950, the Institute is designed to meet the need for correlation between the fields of science and education. Until the founding of the Institute, the training of teachers was left to departments of education and related departments, which resulted in the neglect of the special problems confronting the chemistry teachers and left undeveloped the area of courses designed specifically for them. It was to correct this situation that the Institute for the Teaching of Chemistry was organized.

The Summer Program offers four types of activity: 1) Lecture courses, which are mainly of the survey type and consider both fundamental and advanced ideas in the major fields of chemistry; 2) Seminar in problems of the teaching of chemistry, which treats such subjects as evaluation of student performance, methods of science instruction, course content at various levels; 3) Field Studies, which include visits to industrial plants and laboratories in order to observe current research and developments in industrial chemistry, and visits to institutions carrying on active research such as electron microscope work, microseismograph research, use of the cyclotron, and studies of low-temperature life; and 4) the Special Lectures.

The Special Lecture Program consists of a series of talks by recognized authorities in their fields, on subjects of interest to both teachers and the general public. Spe-

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DR. ELLSWORTH S. OBOURN

In a recent press release Dr. Luther H. Evans, Director General of Unesco, announced the Appointment of Dr. Ellsworth S. Obourn of the John Burroughs School, Clayton, Missouri, to take charge of Unesco's program for the study of science education and the improvement of science teaching in the Member States of Unesco. Dr. Obourn has already served as technical expert and advisor to the Ministry of Education at Bangkok in Thailand in 1952 and 1953 on a Unesco project being carried out under the UN expanded program of Technical Assistance.

The press release goes on to say that "Since one of the primary needs of the underdeveloped countries is the increased use of science in agriculture and industry, there is a universal demand for the expansion of science instruction in the schools. In many countries it has been non-existent, except for university training, and Unesco's first emphasis is on the improvement of science in the primary schools, especially in those countries where 99% of the children do not go beyond fifth or sixth grade. The most important element of Unesco's campaign is the introduction of the laboratory method of instruction and thus of training in the habit of experiment of scientific thought.

Unesco has already sponsored the publication by the Oxford University Press of a series of ten handbooks for teachers, both in primary and secondary schools, in order to aid them in bringing science into their teaching, even in the absence of special courses. The volumes on the teaching of science in primary schools and on the teaching of chemistry in secondary schools have been published. The handbook for primary school teachers is now being translated into Urdu for use in Pakistan.

Earlier, Unesco has also published a series of catalogues, or "inventories" of scientific equipment needed for schools, which list the curricula and the necessary equipment in teaching the various sciences in high schools and universities, engineering schools, medical schools and agricultural colleges. They indicate the price and the source for the procuring of each item.

In addition, for those countries which lack foreign exchange for such purchase, Unesco is publishing this month a series of 80 workshop designs, or "blueprints", for the production of school science equipment by small industries or by vocational schools. There is one portfolio of 80 draw-

ings for elementary schools and another of 76 drawings for secondary schools and university laboratories. They are prepared in the international engineering code and the drawings themselves contain no words so that they are useful in any language. Accompanying them are sheets with full specifications for the purchase of the raw materials, instructions for manufacture on a small scale and on a large scale and instructions for the use of the equipment by the teachers. This project was originally sponsored by the Economic Commission for Asia and the Far East, primarily for the founding and encouragement of small industry in that area. With the aid of the "know-how" provided by Unesco's drawings, many underdeveloped countries will be able to establish the manufacture of scientific equipment and instruments which is essential for science teaching in the schools.

Unesco has also undertaken to organize science teachers' Associations in various countries and is engaged on the continuing study of the curricula used in science teaching throughout the world. It is for the development of this world-wide programme in the modernization of science and in the incorporation of science in general education that Dr. Obourn goes to Unesco.

Dr. Obourn is a widely known person in the field of science education. He has held positions in public and private schools, colleges and universities over the country. He was for ten years Secretary of the National Association for Research in Science Teaching; a member of the National Science Committee of the National Education Association; a member of the Committee of Six of the National Association for the Study of Education which prepared the 46th Yearbook of that organization entitled, "Science Education in American Schools", a member of the Physics Committee of the College Entrance Board; a member and past Director of the National Science Teachers Association and at present active on the International Affairs Committee of that organization.

Dr. Obourn has published textbooks for high school science as well as books on the teaching of science. His latest publication being "Science in Everyday Life" brought out last year. He is also the author of a long list of special articles in educational publications on the problems and methods of science teaching.

While in Thailand, Dr. Obourn spent considerable time studying the problems and needs of teacher education in science, and in designing and building laboratories in teacher training institutions. He was also active in teaching Thailand science teachers how to build and use simple and inexpensive equipment, much of it made from materials found locally."

Members of the *National Association for Research in Science Teaching* are especially pleased that one of its members has been selected for such an important position in promoting and directing better science teaching in the nations associated with the United Nations Educational, Scientific, and Cultural Organization. Dr. Obourn is eminently qualified in every respect for this very important assignment. *Science Education* extends its best wishes to Dr. Obourn on this signal honor that he has received. Dr. Obourn assumed direction of the UNESCO program on April 1, 1954. His work will involve considerable travel in the 60 odd member nations of UNESCO. Dr. Obourn's post is a new one entitled *"Program Specialist in Science Teaching"* in the Department of Natural Science and the Division of Teaching and Dissemination of Science. The program is being planned to reach from the earliest levels of the primary school through Teacher Colleges and the Universities. Dr. and Mrs. Obourn's new address is

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EVALUATION OF CRITICAL THINKING

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INTRODUCTION

EVALUATION in science has dealt primarily with the acquisition of factual information. Other worthy objectives have been recognized but the construction and validation of tests to measure these is a relatively difficult task. One of these objectives is the development of critical thinking.

The purposes of this article are to present (a) the steps by which a classroom teacher of science can construct his own tests to measure certain aspects of critical thinking, and (b) suggestions as to how scores obtained from these tests may be interpreted.

The validity of any evaluation program is in the last analysis determined by the manner and extent with which it fulfills the stated objectives. "Stated objectives will be ignored by students unless evaluation practice honors those objectives with sincere attempts at measurement."[1] That is, a pupil will seek to learn and formulate study habits in keeping with what he expects he will be tested upon. If past experience has shown him that measurement of his learning will be limited to memorization of factual information, then that will determine his method of studying. On the other hand, if he anticipates he will be measured on such abilities as applying principles and interpreting data, he will redirect his studying habits and learning processes. It can thus be seen that among other things, evaluation can be a motivating factor in the attaining of the objectives that have been proposed. Further, if a stated objective, such as the developing of critical thinking, is not included in the evaluation program it may foster pupil cynicism.

Probably one of the best procedures for appraising critical thinking is to place the student in a problem situation where he is required to make decisions vital to him, and then by careful observation and record-keeping, attempt an analysis of his reactions and behaviors. Obviously, this demands time and qualifications beyond the average classroom teacher. Another method that holds good possibilities is the analysis of students' oral and written responses to "thought" questions. An alert teacher can utilize this approach to learn much about "what" students think and even something about the "how" and "why".

This article is an attempt to show how *written* responses may be used as a source of evidence to evaluate certain aspects of critical thinking. Further, this article is limited to the *objective* form of written examinations as compared to the essay type. *If* the abilities selected can be measured by an objective type test, there are certain advantages. Not only do objective examinations possess such characteristics as wide sampling and objective scoring, but also the results are more easily subjected to sharper analysis of the student's thinking.

Before attempting to evaluate critical thinking, it is essential that this term be defined. There seems to be quite common agreement that critical thinking should be defined in terms of abilities. The problem then becomes one of determining what *independent* abilities are associated with this characteristic. The writer at one time listed over thirty abilities ascribed to critical thinking named by various authors. However, upon analysis it becomes apparent that there was much overlapping, i.e., the abilities were not independent.

In an attempt to postulate some abilities that would appear to be independent, the following three were selected.

[1] Troyer, M. E. and Pace, C. R., *Evaluation in Teacher Education*, Washington, D. C., American Council on Education, 1944.

1. Ability to apply principles
2. Ability to interpret data
3. Abilities associated with the nature of proof. (There is some evidence that the first two abilities are sufficiently independent to warrant their separate appraisal.) [2]

To evaluate the abilities requires further analysis to determine what behaviors would best reveal them. ". . . a type of objective such as the development of effective methods of thinking may mean different things to different people. Only as 'effective methods of thinking' is defined in terms of the range of reactions expected of students can we be sure what is to be evaluated under this classification." [3]

With this in mind, the following outline attempts to show how a set of general and specific behaviors may be selected, followed by a step-by-step description of procedures that may be followed in constructing tests similar to the illustrative tests reproduced. It should be noted that the illustrative tests are not speed tests and, therefore, there is no time limit set for their completion. Also, whereas the tests are intended to rely as little as possible on memorized facts, their successful completion is not entirely divorced from factual data. (One cannot think in a vacuum.) However, an attempt is made to state factual data of major importance in the tests to minimize the effect of rote memory.

APPLICATION OF PRINCIPLES TESTS

General Behaviors Involved

Application of known principles for the solution of unfamiliar problems.

[2] Dunning, Gordon M. "The Construction and Validation of a Test to Measure Certain Aspects of Scientific Thinking in the Area of First Year College Physics", *Science Education,* 33 (1949), 121–139.

[3] Smith, Eugene R. and Tyler, Ralph W. *Appraising and Recording Student Progress,* Report of the Committee on Evaluation and Recording of the Commission on Relation of School and College of the Progressive Education Association. New York: Harper and Brothers, 1942.

Specific Behaviors Involved

1. The identifying of statements as being acceptable or unacceptable on the basis of principles or facts used.
2. The identifying of statements as being acceptable or unacceptable when they use analogies, authority, ridicule, or teleological explanations, or when they assume the conclusion.[4, 5]
3. Drawing valid conclusions from given data.[6]

Form Employed for Construction of Tests

1. Present a problem situation followed by statements of the principles and facts involved.[7]
2. Present several statements relevant to the data that the student identifies as True, Uncertain, or False.[8]

Procedures for Construction of Tests

Step 1. Decide on the principle or principles to be tested. Criteria to be considered:

a. should be known principles but the situation in which the principles are to be applied should be new.
b. should involve significantly important principles.
c. should be pertinent to the problem or situation common to all students.
d. should be within the range of comprehension of all students.

[4] The meaning of these terms should be clarified to the students before they take the test.

[5] In these tests the term "principles" is used in a broad sense. It includes any science fact, generalization, or understanding, as well as allowing the use of acceptable analogies and authoritative sources to justify one's conclusion.

[6] Note below in the test construction that a conclusion is demanded only after a student has had an opportunity to think through the problem by answering a series of statements.

[7] Some teachers may prefer to omit the statements of principles and facts involved, thus requiring the students to recall these. Of course, the students' scores would then represent more of a composite of recall as well as application of principles and facts.

[8] The items of the illustrative tests included in this article can all be answered as True or False. The purpose of including the "uncertain" choice is to provide a positive opportunity for a student to say he is not sure rather than to oblige him to leave the answer blank.

e. should use only valid and reliable sources from which to draw data.
f. should be interesting to the students.

Step 2. Determine the phrasing of the problem situations so as to require the student in drawing his conclusion to do one of the following:

a. make a prediction
b. choose a course of action
c. offer an explanation for an observed phenomena
d. criticize a prediction or explanation made by others.

Step 3. Set up the problem situation in which the principle or principles selected operate. Present the problem to a class with the directions to draw a conclusion or conclusions and give several supporting reasons for their answer.

Step 4. Edit the students' responses, selecting those that are most representative of their thinking. These will include conclusions and supporting reasons that are both acceptable and unacceptable.

Step 5. To the conclusions and reasons obtained from the students, the teacher now adds any others that she feels are necessary to cover the salient points. The total number of items should be at least 50% more than is desired in the final form to allow for elimination of poor items. The following list is a guide to the type of statements that can be used:

a. True statements of principles and facts
b. False statements of principles and facts
c. Acceptable and unacceptable analogies
d. Appeal to acceptable or unacceptable authority
e. Ridicule
f. Assumes the conclusion
g. Teleological explanations.

Step 6. Submit test to other judges for criticisms. Revise test in view of criticisms.

Step 7. Administer test. Follow with thorough class discussion.

Step 8. Conduct an item analysis.

Step 9. In the light of steps 7 and 8, revise the test.

Illustrative Tests

APPLICATION OF PRINCIPLES TESTS

A student observed that one of the gas burners on his stove at home did not heat a pan of water as quickly as did the other burners of the same size, even though the valves were opened the same amount. Also, he noted in the first burner that (a) the gas was burning with a yellow color and (b) a soot (carbon) was being deposited on the bottom of the cooking utensils.

The student further observed that in the other burners (a) the gas was burning with a blue flame and (b) no soot (carbon) was being deposited on the cooking utensils.

The Problem

The student thought of two things he might do to increase the heat produced by the burning gas in the first burner.

1. INCREASE THE AMOUNT OF AIR ENTERING THE BURNER.
2. DECREASE THE AMOUNT OF AIR ENTERING THE BURNER.

To help *you* to decide what you would do, read the following principles and facts and then answer the questions below.

Principles and Facts Involved

1. Cooking gas is composed principally of carbon and hydrogen.
2. When substances burn they combine rapidly with oxygen, forming compounds called oxides.
   This rapid oxidation is called combustion.

3. When there is a sufficient amount of oxygen available, the products formed from the combustion of cooking gas are hydrogen oxide (water vapor) and carbon dioxide.
If less oxygen is available, the products formed are mainly water vapor and carbon monoxide. If still less oxygen is available, the product formed is mainly water vapor.
4. The atmosphere is composed of about four-fifths nitrogen and one-fifth oxygen.
5. Nitrogen is an inert gas that does not burn nor does it support combustion.

Directions

On the line before each of the statements below there are three symbols. Mark an X through the correct one.

Symbols	*Meaning*
T	True statement of principle or fact, or an otherwise acceptable statement.
?	You are uncertain
F	False statement of principle or fact, or an otherwise unacceptable statement.

Symbols				*Statements*
T	?	F	1	Soot represents unburned fuel.
T	?	F	2.	The student had noticed that when the representative from the gas company installed the stove, he had increased the opening of the air intake when the flame was yellow. Therefore, the amount of air now entering the burner probably should be increased.
T	?	F	3.	Since the cooking gas contained hydrogen, if too much oxygen is admitted, the gas might explode.
T	?	F	4.	If more air is admitted there will be an increase of about four times as much nitrogen as oxygen entering the burner.
T	?	F	5.	Decreasing the amount of air entering the burner will prevent soot from forming and will increase the heat produced by the burning gas.
T	?	F	6.	Anyone can see that all that has to be done is to close partly the valve of the first burner.
T	?	F	7.	The formation of soot is the result of more cooking gas entering the first burner than the other burners.
T	?	F	8.	A coal fire in a furnace will produce more smoke when burning with the drafts closed. Likewise, the burning gas forms more soot when there is an insufficient amount of air.
T	?	F	9.	The color of the flame of burning gas is related to the heat produced.
T	?	F	10.	Admitting more air will mean that there is more oxygen available for combustion.
T	?	F	11.	Soot results from impurities in the gas.
T	?	F	12.	If part of a fuel does not oxidize, the maximum amount of heat will not be produced.
T	?	F	13.	If considerably more air is admitted, the soot that formed before will now burn; thus the amount of poisonous carbon monoxide present must increase.
T	?	F	14.	A classmate of the student told him that when he used an old gas stove at home it produced soot, and that this was to be expected after using a stove for some time.
T	?	F	15.	The amount of air and gas entering a burner may be regulated separately.
T	?	F	16.	Cooking gas may appear to burn even though all of its elements may not combine with oxygen.
T	?	F	17.	When a strong wind blows on a campfire, more dust and ashes are blown into the air. Likewise, admitting more air to the burner will cause more soot to form.
T	?	F	18.	The other burners on the stove may be burning a different type of cooking gas, thus accounting for the difference in heat produced.
T	?	F	19.	Decreasing the amount of air entering the burner will allow more thorough mixing of the gas and air, resulting in more complete combustion.
T	?	F	20.	The soot was formed because the cooking utensils were placed over the burning gas.
T	?	F	21.	Increasing only the amount of nitrogen entering the burner will *not* cause the gas to burn any better.
T	?	F	22.	Increasing the proportion of air will cause the gas to burn too fast, thus decreasing its efficiency.

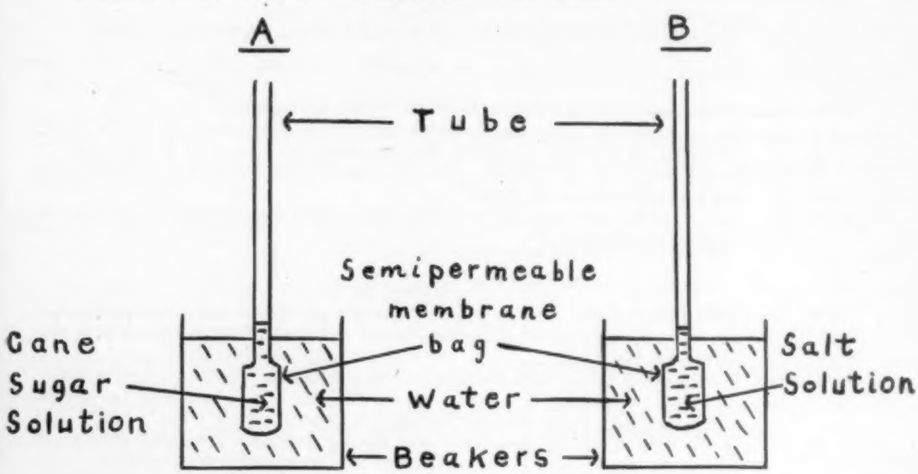
Conclusion

In the light of your answers above, place a check mark (X) before one of the following statements.

...... 1. The amount of air entering the burner should be increased.
...... 2. The amount of air entering the burner should be decreased.
...... 3. Neither of the above procedures would increase the heat produced by the burning gas.

APPLICATION OF PRINCIPLES TEST

A student set up two parts of an experiment as shown below.



The salt solution has a higher concentration than the cane sugar solution, otherwise all other factors in the two parts are equal.

The Problem

WHEN THE APPARATUS IS ALLOWED TO STAND, WILL
(A) THE LIQUID RISE TO A GREATER HEIGHT IN TUBE *A* OR *B*, OR
(B) THE LIQUIDS RISE TO THE SAME HEIGHT, OR
(C) IT BE IMPOSSIBLE TO PREDICT THE RELATIVE HEIGHTS?

Principles and Facts Involved

1. Cane sugar and salt can dissolve in water, forming a solution. The more cane sugar or salt dissolved in a given amount of water, the higher is the concentration of the solution.
2. Cane sugar molecules cannot pass (diffuse) through a semi-permeable membrane.
3. Salt and water molecules can pass either way (diffuse) through a semi-permeable membrane.
4. When two liquids of different concentration are separated by a semi-permeable membrane, there will be a greater flow of water through the membrane toward the liquid of higher concentration.
5. The greater the *difference* in concentration that is *maintained* between the liquids within and without the semi-permeable membrane bag, the greater the height to which the liquid will rise in the tube before the force of gravity prevents it from rising higher. (Neglect any other factors).

Directions

On the line before each of the statements below there are three symbols. Mark an X through the correct one.

Symbols	*Meaning*
T	True statement of principle or fact, or an otherwise acceptable statement.
?	You are uncertain.
F	False statement of principle or fact, or an otherwise unacceptable statement.

Symbols *Statements*

Just after this experiment begins:

T ? F 1a. More water will pass into either bag than passes out of the same bag.
T ? F 2a. The concentration of salt will be increasing in the water in beaker *B*.
T ? F 3a. The liquid in tube *B* will be rising at a faster rate than the liquid in tube *A*.
T ? F 4a. More and more cane sugar molecules will be found in the water of beaker *A*.
T ? F 5a. The concentration of the cane sugar solution will be decreasing within the bag and tube *A*.
T ? F 6a. Less and less molecules of salt will be found within the bag and tube *B*.

* * * * * * *

When either liquid just reaches its greatest height in this experiment:

T ? F 1b. The concentration of the liquids within and without their own bags will be equal.
T ? F 2b. The diffusion of water molecules into the membrane bag *A* or *B* will cease.
T ? F 3b. The *difference* in concentration between the liquids within and without their own bag will be at a maximum.
T ? F 4b. Salt molecules will continue to diffuse from within the membrane bag *B* to the liquid in the beaker.

* * * * * * *

T ? F 1c. The skin of raisins acts as a semi-permeable membrane and when raisins are set in water they swell. Likewise, water will enter both bags and push the liquids up the tubes.
T ? F 2c. The liquid in part *A* will continue to rise indefinitely.
T ? F 3c. The sugar molecules will settle to the bottom of bag *A* and tend to prevent water molecules from entering the bag.
T ? F 4c. If the weights of the cane sugar and the salt solutions are equal, they must rise to the same height in the tubes since gravity is acting alike on both.
T ? F 5c. We may be quite sure that the concentration of the two liquids in part *A* will *not* become equal.
T ? F 6c. Since the salt solution has a higher concentration than the cane sugar solution, it must rise to a greater height.
T ? F 7c. The difference in concentration between the cane sugar and the salt solutions must be known more specifically to predict the outcome of this experiment.
T ? F 8c. The relative quantities of the liquids originally used within the bag and beaker of part *B* will affect the height to which the liquid will rise within the tube.
T ? F 9c. If the liquids are to rise up their tubes, it is obvious that water cannot pass from within the bags to the liquids in the beakers.
T ? F 10c. It is difficult to predict the results of this experiment because cane sugar is an organic compound and salt is an inorganic compound.
T ? F 11c. The number of cane sugar molecules within the bag and tube will remain constant throughout the experiment.
T ? F 12c. Water will pass in and out of both membrane bags during all of the time the experiment progresses.
T ? F 13c. The answer to the problem cannot be predicted because the liquids will rise up their own tubes at different rates.
T ? F 14c. If stones are placed in a vessel containing water, the water level will rise. Likewise, the sugar will act in the same manner and push the water level upward by an amount equivalent to the volume of the sugar molecules.
T ? F 15c. When the liquids reach a given height at some time during their rise, the *difference* in concentration between the liquids within and without the membrane bag must be the same in bag *A* as in bag *B*.
T ? F. 16c. Without knowing the rate of diffusion of salt molecules, it is difficult to predict the results of this experiment.

Conclusion

In the light of your answers above, check one of the following conclusions.

...... 1. The liquid will rise to the greater height in tube *A*.

...... 2. The liquid will rise to the greater height in tube *B*.
...... 3. The liquids will rise to the same height.
...... 4. It is impossible to predict in this experiment which liquid will rise to a greater height.

INTERPRETATION OF DATA TESTS

General Behaviors Involved

Recognizing
 (1) relationships in data
 (2) limitations of data

Specific Behaviors Involved

When interpreting a given set of data, how frequently a studetnt:

(1) was accurate
(2) was too cautious
(3) went beyond the data
(4) was in error

General Form Employed in Construction of Tests

1. The data is presented, followed by several descriptive statements.
2. The student identifies each statement as being True, Probably True, Insufficient Evidence, Probably False or False.

Procedures for Construction of Tests

Step 1. Decide on the area or concept from which to draw the data.

Criteria to be considered:

a. Should be data not previously interpreted
b. Should involve significantly important data
c. Should be pertinent to a problem or situation common to all students
d. Should be within the range of comprehension of all students
e. Should use only valid and reliable sources from which to draw data
f. Should be interesting to the students

Step 2. Determine what form is most suitable for the presentation of the data.

Varieties of forms:

a. Graphic
 1. Graphs
 2. Charts
 3. Tables
 4. Pictures
 5. Maps
b. Prose

Step 3. Set up the data in the form selected in Step 2.

Step 4. Present the data to a class of students with the directions to write five (or any appropriate number) of conclusions that would be justified by the data.[9]

Step 5. Edit the students' answers, selecting those that are most representative of their thinking. These conclusions will undoubtedly include statements that should be categorized as true, probably true, insufficient evidence, probably false, and false.

Step 6. To the conclusions obtained from the students, the teacher now adds any others that she feels are necessary to cover the salient relationships. The total number of items should be at least 50% more than is desired in the final form, to allow for elimination of poor items. Below is a suggestive list of types of statements that may be formulated to be answered as true, or false, probably true or probably false, and insufficient evidence.

a. True or false
 They are statements which:
 1. make comparison of points. The statements are a comparison of two or more points or items in the data.
 2. record ranges. The statements present ranges within which certain parts or all of the data falls.
 3. consider trends. The statements describe trends in the data that can be recognized and interpreted without qualifications.
 4. contrast trends. The statements compare two or more trends in the data that can be recognized and interpreted without qualifications.
 5. summarize the data. The statements summarize the data in terms that may be recognized and interpreted without qualifications.
 6. make new groupings of data. The statements present the data in a new organization but retain the facts so that they may be recognized and interpreted without qualifications.
b. Probably true or probably false
 They are statements which:
 1. extrapolate. The statements formulate a likely or unlikely prediction of a point, fact, or trend which lies beyond the data given.
 2. interpolate. The statements formulate likely

[9] Such conclusions should involve relationships between two or more facts and not be a restatement of a single fact. Here a teacher will need to give examples, and help the students get started in what is probably a new type of work to them.

or unlikely predictions of a point, fact or trend which lie between points or facts given in the data.

3. show cause-effect relationships. The statements present cause-effect relationships that are indicated but not proven by the data given.
4. present value judgment. The statements present a course of action or opinions that are likely to be true or false.
5. draw likely or unlikely generalizations from adequate samplings.

c. Insufficient evidence

They are statements which:

1. extrapolate. The statements extrapolate the trend too far or extrapolate when there is no trend.
2. present unsound judgment. The statements give courses of action or opinions for which there is no, or insufficient substantiation.
3. show cause-effect relationships. The statements unwarrantedly assign causes or predict effects.
4. assign purpose. The statements attribute purpose to the problem.
5. draw generalizations from inadequate samplings.
6. attribute values to outcomes.

There is no set proportion of these types of items to be used, but those based on insufficient evidence, probably true or probably false should predominate since these will probably require a deeper understanding of the relationships involved in the data.

Step 7. Submit test to other judges for criticisms. Revise test in view of criticisms.

Step 8. Administer test. Follow with thorough class discussion.

Step 9. Conduct an item analysis.

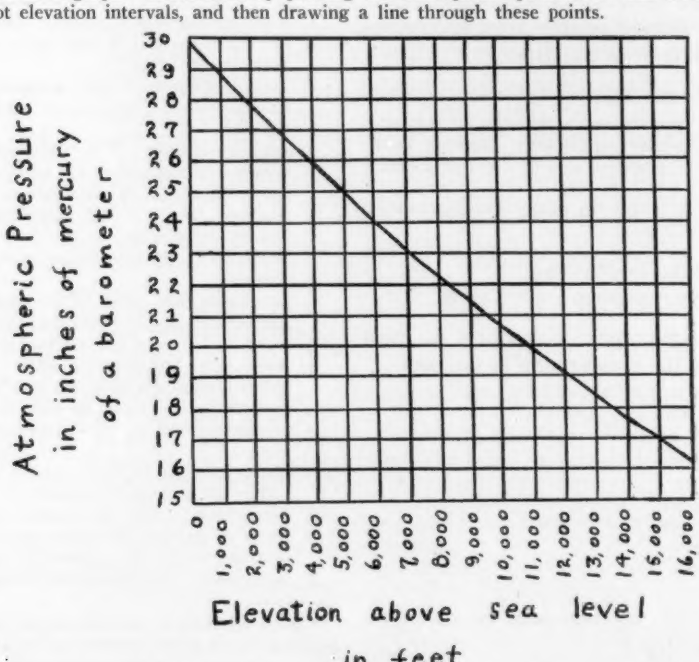
Step 10. In the light of steps 8 and 9, revise the test.

Illustrative Tests

INTERPRETATION OF DATA

NAME.. DATE.....................
(Last) (First)

Below is a graph* constructed by plotting the atmospheric pressure at sea level and at 1,000 foot elevation intervals, and then drawing a line through these points.



* Reproduced from Semat: Fundamentals of Physics, by permission of Rhinehart and Company, Inc.

Directions: On the line before each of the statements below there are five symbols. Mark an X through the correct one.

T	True:	The information given here proves conclusively the statement is true
PT	Probably True:	The information given here indicates that the statement is likely to be true but is not sufficient to prove its truth
I	Insufficient Evidence:	There is not sufficient information given here to indicate whether there is any degree of truth or falsity in the statement
PF	Probably False:	The information given here indicates that the statement is likely to be false but is not sufficient to prove its falsity
F	False:	The information given here proves conclusively that the statement is false.

Symbols		*Statements*
T PT I PF F	1.	There are 17 points plotted on the graph.
T PT I PF F	2.	The atmospheric pressure at 17,000 feet is more than 16 inches of mercury.
T PT I PF F	3.	The graph shows the atmospheric pressure at 7,000 feet as approximately 23 pounds per square inch.
T PT I PF F	4.	The information given in the graph was collected to aid in weather predictions.
T PT I PF F	5.	The atmospheric pressures recorded are the average of several taken at the same time.
T PT I PF F	6.	If measurements of atmospheric pressure were made and plotted on different days, the graphs would be identical.
T PT I PF F	7.	Plotting atmospheric pressures for every 500 feet and drawing a line through these points, will result in a graph line almost the same as the one based on 1000 foot readings.
T PT I PF F	8.	The atmospheric pressure decreases the same amount for every 1000 foot increase in elevation above sea level.
T PT I PF F	9.	Ascending to elevations over 16,000 feet will produce a nose bleed.
T PT I PF F	10.	The graph does not record any atmospheric pressure below sea level.
T PT I PF F	11.	The atmospheric pressure at an elevation of 9,500 feet is 21 inches of mercury.
T PT I PF F	12.	With a change in weather conditions, the atmospheric pressure will become less.
T PT I PF F	13.	Between 16,000 feet and 20,000 feet altitude the graph line will show a rather marked change in direction.
T PT I PF F	14.	There are no readings over 16,000 feet because the recorders were unable to reach a higher altitude with their equipment.
T PT I PF F	15.	An extension of the graph line to the left will represent the atmospheric pressures in an open mine below sea level.
T PT I PF F	16.	The atmospheric pressure at 32,000 feet will be three inches of mercury.
T PT I PF F	17.	The atmospheric pressure at 11,000 feet is approximately two-thirds that at sea level.
T PT I PF F	18.	The atmospheric pressures recorded were taken at a latitude of 0°.
T PT I PF F	19.	The changes in atmospheric pressure at increasing altitudes was a primary cause for a toy rubber balloon to expand at a fairly uniform rate as it rose in the atmosphere.
T PT I PF F	20.	The graph shows a range in atmospheric pressure from 0 to 30 inches of mercury.
T PT I PF F	21.	Another graph constructed in a similar manner at another locality will show somewhat the same changes in atmospheric pressure as elevation increases.
T PT I PF F	22.	A person who can just "suck up" mercury 15 inches into a tube when at an altitude of 7,000 feet, can "suck up" mercury to a greater height in the straw when at a lower elevation.
T PT I PF F	23.	The atmospheric pressures were taken during the summer months.
T PT I PF F	24.	The atmospheric pressure at 1,000 feet below sea level is approximately twice as great as at 17,000 feet above sea level.

Interpretation of Data Test

A student performed an experiment using white rats. He put six rats in each of two cages and fed them all a balanced diet for five days. He recorded the following information:

	Group A	*Group B*
1. On the first day: the average weights of the rats were.........	125 grams	120 grams
2. On the 5th day: the average weights of the rats were...........	134 "	129 "

3. He continued to feed Group B the balanced diet, but now fed Group A on *beef fat* only. On the 20th day: the average weights of the rats were	111 "	152 "
4. Group A was now fed *potatoes* in addition to the beef fat. Three days later one rat in Group A died. On the 40th day: the average weights of the rats were..........	117 "	175 "
5. Group A was now fed *bread* in addition to the beef fat and potatoes. On the 54th day: the average weights of the rats were....	136 "	190 "

Directions: On the line before each of the statements below there are five symbols. Mark an X through the correct one.

T True:	The information given here proves conclusively the statement is true
PT Probably True:	The information given here indicates that the statement is likely to be true but is not sufficient to prove its truth
I Insufficient Evidence:	There is not sufficient information given here to indicate whether there is any degree of truth or falsity in the statement
PF Probably False:	The information given here indicates that the statement is likely to be false but is not sufficient to prove its falsity
F False:	The information given here proves conclusively that the statement is false.

Symbols	*Statements*
T PT I PF F	1. From the 6th to the 20th day, group *A* rats lost as much weight as group *B* gained in weight.
T PT I PF F	2. Feeding group *A* the same diet as group *B* throughout the experiment would have resulted in both groups gaining about the same weight.
T PT I PF F	3. Continuing the same diets for another three weeks after the 54th day would result in the average weights of the two groups of rats being more nearly equal.
T PT I PF F	4. A diet of beef fat, potatoes, and bread contains more calories than the balanced diet.
T PT I PF F	5. Group A gained weight faster on a diet of beef fat and potatoes than they lost weight on a diet of beef fat alone.
T PT I PF F	6. If group A had been fed on beef fat alone for a longer time, they would have become more accustomed to this diet and would not continue to lose weight.
T PT I PF F	7. Since group A increased in weight when potatoes were added to their diet, they would have weighed almost as much as they did by the 54th day without the addition of bread.
T PT I PF F	8. The proportion of sexes within each group of rats was the same.
T PT I PF F	9. At some time between the 6th and the 20th day, the average weights of the two groups of rats were equal.
T PT I PF F	10. At the beginning of the experiment each of the rats in group A weighed more than any of those in group B.
T PT I PF F	11. When another two sets of rats similar to those used are subjected to the same experiment, the relative weight changes will generally be the same.
T PT I PF F	12. If one of the rats in group A had not died, the weight recorded on the 40th day would have been more than 117 grams.
T PT I PF F	13. Group A would have gained considerably more in weight than did group B if a diet of beef fat, potatoes and bread had been fed group A from the 6th day on.
T PT I PF F	14. A diet of beef fat, potatoes and bread, fed to group A starting on the 6th day, would have produced a greater weight increase per day than it did starting on the 40th day.
T PT I PF F	15. One of the rats in group A died because the addition of potatoes resulted in too heavy a diet of starch.
T PT I PF F	16. Bread, added to the diet of beef fat alone for group A, would at least retard their loss in weight.
T PT I PF F	17. The rats used in this experiment were *not* full grown adults.
T PT I PF F	18. Feeding group A the same diet as group B throughout the experiment would have resulted in both groups gaining about the same weight.

T PT I PF F 19. The rats in group A started gaining weight within the first 12 hours after potatoes were added to the diet of beef fat.

T PT I PF F 20. If the diet of the rats in group A were continued indefinitely as planned between the 6th and 20th day except that beef fat was eliminated, the diet would not be adequate to sustain life.

T PT I PF F 21. Humans will show similar relative weight changes when fed diets similar to those of the rats.

T PT I PF F 22. The *rate* of increase in weight during the last 14 days was greater for group A than for group B.

T PT I PF F 23. The rats in group A weighed more than those in group B at the start of the experiment because they were fed more.

T PT I PF F 24. If a balanced diet is continued for group B, the average weight of the rats will be greater than 195 grams when they are full grown.

T PT I PF F 25. Continuing a diet of beef fat alone for several weeks after the 20th day would have resulted in more than one rat dying in group A.

T PT I PF F 26. If the diet of beef fat and potatoes had been continued through the 41st day, another rat would have died.

T PT I PF F 27. The data would suggest that at the beginning of the experiment both groups of rats had about equal ability to increase in weight.

T PT I PF F 28. Even if the rats of group A eventually caught up with group B in weight, some of the rats of group A would die before any of the rats in group B.

T PT I PF F 29. The differences in weights on the 5th day and 54th day was about 30 times greater for group B than for group A.

T PT I PF F 30. These data prove that a diet of beef fat, potatoes and bread contains all of the nutrients and in the proper proportion for a balanced diet.

NATURE OF PROOF TESTS

General Behaviors Involved

1. Appraising the relevance of arguments.
2. Distinguishing between facts and assumptions offered as proof.

Specific Behaviors Involved

1. Distinguishing between facts that are relevant or irrelevant to an argument.
2. Distinguishing between facts and assumptions presented in support of an argument.
3. Identifying those basic assumptions upon which the proof depends.

General Form Employed for Construction of Tests

1. Present the problem situation with a stated conclusion.
2. Present several statements including:

a. facts relevant to an argument
b. facts irrevelant to an argument
c. assumptions upon which the proof depends
d. assumptions unnecessary to the proof

The student identifies each statement as falling into one of the above categories.

Procedures for Construction of Tests

Step 1. Decide on the nature of the problem to be presented. Criteria to be considered:

a. should use a general situation familiar to students, or include sufficient information in describing the problem to provide the student with the necessary data from which he can operate.
b. should involve significantly important concepts.
c. should be pertinent to problem or situation common to all students.
d. should be within the range of comprehension of all students.
e. should use only valid and reliable sources from which to draw data.
f. should be interesting to the students.

Step 2. Describe a problem situation following which a conclusion or assertion is made, based on the data presented in the problem. First ask the students to write several facts that must be considered in reaching a conclusion. Second, tell the students that in order to reach the stated conclusion, several assumptions must have been made. Then ask them to write several assumptions that must be made and accepted as true before the stated conclusions can also be accepted.

Step 3. As a result of Step 2, the teacher will undoubtedly have obtained (a) rele-

vant and irrelevant facts, (b) necessary and unnecessary assumptions. Edit these responses and select those that are most representative of the students' thinking.

Step 4. To the statements collected as a result of Steps 2 and 3, the teacher will add her own, *making sure to include all the necessary assumptions that must be made to establish the proof of the conclusion.* The statements then fall into four categories:

a. statements of relevant facts
b. statements of irrelevant facts
c. statements of necessary assumptions
d. statements of unnecessary assumptions

After including all of the necessary assumptions that must be made, there is no set number of proportion of items to be used. Each particular problem may best lend itself to different numbers and proportions.

Step 5. Submit test to other judges for criticisms. Revise test in view of criticisms.

Step 6. Administer test. Follow with thorough class discussion.

Step 7. Make an item analysis.

Step 8. In the light of Steps 6 and 7, revise the test.

Illustrative Tests

Nature of Proof

A student performed the following experiment:

1. Measured off 1/5 of the distance from the rim to the bottom of an ordinary driking glass and *marked this point.*
2. Took about a teaspoonful of moistened iron filings that had been lying on the table overnight and dropped them into the glass so they stuck to the bottom half.
3. Inverted the glass containing the iron filings into a dish of water so that no air escaped from the glass.
4. Left the apparatus for 18 hours.

The student knew that moistened iron filings would combine only with the oxygen of the air within the glass to form iron oxide (iron rust). This would create a partial vacuum and the atmospheric pressure would push the water up within the glass. Since he knew that the atmosphere is about 1/5 oxygen and 4/5 nitrogen and rare gases, the student concluded that:

At the end of 18 hours the water level within the glass would be at the mark he had made on the glass.

This conclusion may or may not be true, depending on various factors in the experiment. By marking the statements below, according to the directions, you will be analyzing the student's argument (conclusion).

Directions

Before each of the statements below are four symbols. Mark an X through the correct one.

Symbols	*Meaning of Symbols*
F Relevant fact:	The statement is an accepted fact and does have a bearing on the argument.
f Irrelevant fact:	The statement is an accepted fact but has little or no bearing on the argument.
A Necessary assumption:	The statement may or may not actually be true, but it must be accepted as true if the student is to prove his conclusion.
a Unnecessary assumption:	The statement may or may not actually be true, and even if accepted as true, is not necessary for the students' proof.

Symbols		*Statements*
F f A a	1.	Iron filings do *not* combine with the nitrogen of the air within the glass.
F f A a	2.	The area of the water in the dish exposed to the atmosphere is at least as great as the area under the glass.
F f A a	3.	Other metals besides iron will combine with oxygen.
F f A a	4.	The water level rose within the glass the same amount during each hour of the experiment.
F f A a	5.	There was sufficient water in the dish to fill up the glass to the mark.
F f A a	6.	The rusting of iron is a relatively slow process.

F f A a 7. The more oxygen that is removed from the air within the glass, the better will be the vacuum.
F f A a 8. Drinking water is used in this experiment.
F f A a 9. All of the oxygen of the air within the glass does combine with the iron filings.
F f A a 10. No air escaped when the glass was inverted in the dish of water.
F f A a 11. After 18 hours the air remaining within the glass is only nitrogen and rare gases.
F f A a 12. The glass used was less than 30 inches in height.
F f A a 13. The iron filings do *not* occupy a very large proportion of the volume within the glass.
F f A a 14. The diameter of the glass is uniform throughout.
F f A a 15. Iron oxide will *not* dissolve in the water contained in the dish.
F f A a 16. Iron oxide is a stable substance that does *not* decompose into its original elements.
F f A a 17. The water level within the glass will *not* reach the mark before the 18 hours is completed.
F f A a 18. No air that may have been dissolved in the water escapes into the glass.
F f A a 19. When moistened iron filings are left exposed to the atmosphere of a room, some of the filings may be found to have rusted.
F f A a 20. Other factors being equal, the taller the glass used the greater the height (in inches) to which the water will rise within the glass.
F f A a 21. Heat is produced so slowly by the process of slow oxidation that it is transmitted to the surroundings before it heats up the air within the glass to any extent.
F f A a 22. If the water level had reached the point on the glass marked by the student by the end of 9 hours, then one-half of the iron filings would remain uncombined with the oxygen.
F f A a 23. The water level in the dish does *not* fall below the rim of the glass during the experiment.
F f A a 24. The iron filings will remain inside of the glass for 18 hours.
F f A a 25. When a vacuum is created within some containers, they will collapse.
F f A a 26. If air escapes from an "empty" glass inverted into water, the water level will rise within the glass.
F f A a 27. The amount of water used is just enough to fill the glass to the mark and keep the bottom of the dish covered to the same depth as the mark on the glass.
F f A a 28. Although oxygen is slightly heavier than nitrogen gas, the molecules of oxygen will not remain near the bottom of the glass but will continually move about within the glass.
F f A a 29. The longer the iron filings are exposed to the gases within the glass, the more iron oxide will be formed, providing there is oxygen present.
F f A a 30. The atmospheric pressure does *not* undergo a large change during the 18 hours.
F f A a 31. Water is made up of two parts hydrogen and one part oxygen.
F f A a 32. The diameter of the glass is greater than that of a barometer tube.
F f A a 33. The rim of the glass is held just under the water level at the end of 18 hours.

Nature of Proof Test

A student mated two rats (first generation), both of which possessed a characteristic that had been shown to depend upon the presence of a single dominant gene *A*, which was not sex-linked. The first litter (second generation) of four rats all showed this same characteristic.

The student claimed that if he mated two of these second generation rats:

All of their immediate offspring (third generation) MUST *show this same characteristic.*

This conclusion may or may not be true. By marking the statements below, according to the directions, you will be analyzing the student's argument (conclusion).

Directions

Before each of the statements below are four symbols. Mark an X through the correct one.

Symbols	*Meaning of Symbols*
F Relevant fact:	The statement is an accepted fact and does have a bearing on the argument.
f Irrelevant fact:	The statement is an accepted fact but has little or no bearing on the argument.

A Necessary assumption: The statement may or may not actually be true, but it must be accepted as true if the student is to prove his conclusion.

a Unnecessary assumption: The statement may or may not actually be true, and even if accepted as true, is not necessary for the students' proof.

Symbols					*Statements*
F	f	A	a	1.	All of these first and second generation rats possess at least one *A* gene.
F	f	A	a	2.	If the genetic makeup of the second generation father is *Aa*, then the mother is *AA*.
F	f	A	a	3.	Some characteristics require more than one pair of genes for their transmission.
F	f	A	a	4.	Recessive genes may be present, together with dominant genes, but have no apparent effect on visible characteristics.
F	f	A	a	5.	The first and second generation rats were about the same age when mated.
F	f	A	a	6.	Both of the first generation parents are of the genetic makeup *AA*.
F	f	A	a	7.	Both sexes are represented in the second generation.
F	f	A	a	8.	Rats may look alike in respect to a characteristic and yet have different genetic makeups.
F	f	A	a	9.	All of the third generation offspring possess at least one *A* gene.
F	f	A	a	10.	If the genetic makeup of the second generation father is *AA*, then the mother is also *AA*.
F	f	A	a	11.	The rats of the third generation will look alike in characteristics other than the one studied.
F	f	A	a	12.	If the genetic makeup of one of the first generation parents is *AA* and the other *aa*, all members of the second generation will show the characteristic determined by the *A* gene.
F	f	A	a	13.	If there are many third generation rats bred, it is probable that both sexes will be present.
F	f	A	a	14.	The total number of *A* genes possessed by the two rats mated in the second generation is at least three.
F	f	A	a	15.	There can be different numbers of rats in different litters.
F	f	A	a	16.	If the genetic makeup of the second generation parents is *AA* and *Aa*, some of the third generation *may* possess one *a* gene.
F	f	A	a	17.	The characteristics determined by single dominant genes are present in future generations whenever these dominant genes are transmitted.
F	f	A	a	18.	All third generation offspring are of the genetic makeup *AA*.
F	f	A	a	19.	There is *no* recessive gene *a* in either rat of the first generation.
F	f	A	a	20.	If a characteristic is determined by the presence of a single dominant gene, and both parents possess only one of such dominant genes, all of their offspring *can* show this characteristic.
F	f	A	a	21.	Any gene found in the third generation must have been transmitted through the first and second generation. (Neglecting mutations)
F	f	A	a	22.	If the genetic makeup of the second generation mother is *Aa* then the father is *AA*.
F	f	A	a	23.	The genetic makeup of the first generation rats are identical in respect to *A* or *a* genes.
F	f	A	a	24.	A pair of genes may be transmitted unaffected by the transmission of other genes at the same time.
F	f	A	a	25.	When the second generation rats were interbred, it meant that brother and sister were mated.
F	f	A	a	26.	None of the rats in any of the three generations possess two recessive genes.
F	f	A	a	27.	If the genetic makeup of the first generation father is *Aa*, then the mother is *AA*.
F	f	A	a	28.	If two other rats are mated from the same litter as the first generation rats, all of their offspring will show this same characteristic.
F	f	A	a	29.	All the rats in any single litter *may not* be equally healthy.
F	f	A	a	30.	In all three of these generations the same characteristic depends only on gene *A*.
F	f	A	a	31.	All rats of the third generation will have the same genetic makeup.
F	f	A	a	32.	Characteristics other than the one studied can be transmitted by a single dominant gene.
F	f	A	a	33.	If both first generation rats are of the genetic makeup *AA*, all rats of future generations must show this same characteristic.
F	f	A	a	34.	All three generations of rats were kept in similar environments.

POINT SCORING

I. Application of Principles

Below are described two methods of scoring application of principles tests.

Method 1

Since this is in essence a "True-False" type test, subtract the number of wrong answers from the number of right answers. (The items marked "?" or left blank by the student will thus be scored a zero.) Arbitrarily, add five points (or any other number a teacher sees fit) for a correct conclusion. This constitutes the student's raw score.

Method 2

The simplest method is merely to credit one point for each correct response and arbitrarily add five points (or any other number a teacher sees fit) for a correct conclusion. This constitutes the student's raw score.

This method assigns a zero value to a "False" and "?" or blank answer. The argument for marking a "?" answer as zero is that each statement does have a correct answer and it is the student, not the statement, who is in doubt. Presumably, each statement is answerable with a "True" or "False" response.

Method 2 makes no correction factor for guessing. However, most students will probably find the whole idea of an application of principles test relatively more difficult than the usual factual examination. Therefore, from the viewpoint of increased student morale, this method of scoring may be more suitable.

II. Interpretation of Data

A. Discussion:

Below are described two methods of scoring interpretation of data tests.

Method 1

The simplest method of scoring is merely to credit one point for each correct response and add these numbers. This yields the student's raw score. There is some evidence that this yields at least as valid and reliable scores as more complicated methods.[10] However, other methods of scoring may be used, depending upon the teacher's philosophy of grading.

Method 2

Probably method 2 is the best from the viewpoint of pupil morale. It provides for reduction in credit the more distant the student's response is from the correct answer. For example, if the correct answer is "True", the student who answers "Probably True" is not as much in error as one who answers "Insufficient Evidence." Nor is this second student as much in error as a third who answers "Probably False," etc. This line of reasoning leads to the scoring chart below where each step deviation from the correct answer will give the student one less point.

It will be seen that a student who is one step away from the correct answer on four questions will not lose any more points than a student who is four steps away from the correct answer on only one question. This may be explainable on the basis of problem solving. The first student will encounter difficulty in finding a solution

SUGGESTIVE CHART TO BE FOLLOWED IN POINT SCORING BY METHOD 2

		Teacher's Key				
		T*	PT	I	PF	F
Student's	T	4	3	2	1	0
Answer	PT	3	4	3	2	1
	I	2	3	4	3	2
	PF	1	2	3	4	3
	F	0	1	2	3	4

* T True
PT Probably True
I Insufficient Evidence
PF Probably False
F False
A blank answer is scored zero

[10] Dunning, Gordon M. The Construction and Validation of a Test to Measure Certain Aspects of Scientific Thinking in the Area of First Year College Physics, *Science Education*, 33 (1949): 121–139.

because he is a little too cautious or goes one step beyond the data; but the second student will probably have even greater difficulty because he is dead wrong on one of his conclusions.

Step 1. Construct a cardboard template as shown below.

		Teacher's Key				
		T	PT	I	PF	F
Student's Answers	T	A* 4 cut out	BD 3 cut out	BD 2 cut out	E 1 cut out	E 0 cut out
	PT	C 3 cut out	A 4 cut out	BD 3 cut out	E 2 cut out	E 1 cut out
	I	C 2 cut out	C 3 cut out	A 4 cut out	C 3 cut out	C 2 cut out
	PF	E 1 cut out	E 2 cut out	BD 3 cut out	A 4 cut out	C 3 cut out
	F	E 0 cut out	E 1 cut out	BD 2 cut out	BD 3 cut out	A 4 cut out

* Meaning of letters above cut-out portions of chart.[11]

A—accurate
C—too cautious
BD—beyond data
E—error

Step 2. Slip a blank sheet of paper under the cardboard form for each pupil.
Step 3. Place a mark (1) in the appropriate box for each question answered.
Step 4. Multiply the number of marks in each cut out by the figure found at the left of that cut out and add all of these points. This constitutes the student's raw score.

III Nature of Proof

A. Discussion

Below are described two methods of scoring nature of proof tests.

Method 1

The simplest method of scoring is merely to credit one point for each correct response and add these numbers. This yields the student's raw score.

Method 2

Basically, the abilities involved are (a) to determine relevance of a statement to an argument and, (b) to distinguish between facts and assumptions. If a student fails in both he is more in error than if he fails in one or the other. The suggestive scoring chart below is based on this premise.

SUGGESTIVE CHART TO BE FOLLOWED IN POINT SCORING BY METHOD 2

		Teacher's Key			
		F*	f	A	a
Student's Answer	F*	2	1	1	0
	f	1	2	0	1
	A	1	0	2	1
	a	0	1	1	2

*F—relevant fact
f—irrelevant fact
A—necessary assumption
a—unnessary assumption

B. Procedure in point scoring by method 2.

Step 1. Construct a cardboard template as shown below.

		Teacher's Key			
		F	f	A	a
Student's Answer	F	A* 2 cut out	R 1 cut out	D 1 cut out	R+D 0 cut out
	f	R 1 cut out	A 2 cut out	R+D 0 cut out	D 1 cut out
	A	D 1 cut out	R+D 0 cut out	A 2 cut out	R 1 cut out
	a	R+D 0 cut out	D 1 cut out	R 1 cut out	A 2 cut out

* Meaning of letters above cut-out portions of chart:[12]

A—accurate
D—failed to distinguish between facts and assumptions
R—failed to recognize relevance of statement
R+D—failed in both
A blank answer is scored zero

Step 2. Slip a blank sheet of paper under the cardboard form for each pupil.
Step 3. Place a mark (1) in the appropriate box for each question answered.
Step 4. Multiply the number of marks in each cut out by the figure found at the left of that cut out and add all of these points. This constitutes the student's raw score.

SCORING ON THE BASIS OF BEHAVIOR INVOLVED

Discussion

The total point score gives the best single summarizing score, but it also tends to conceal the strengths and weaknesses of the

[11] The use of the letters above the cut-out portions is discussed later.

[12] The use of the letters above cut-out portions is discussed later.

student. There are other methods of scoring that are more meaningful in their interpretation of the student's abilities as revealed in the behaviors exhibited.

There follows outlines of suggestive procedures for this kind of interpretation of scores in application of principles, interpretation of data and nature of proof.

I Application of Principles Tests.

A. Discussion

The specific behaviors involved in the application of principles have been proposed as

(1) The identifying of statements as being
   (a) acceptable or unacceptable: principles or facts
   (b) acceptable or unacceptable: use of analogies, authority, ridicule, or teleological explanations, or when they assume the conclusion

(2) Drawing valid conclusions from given data

The procedure then becomes one of determining how many test items are based on each of the above behaviors and how many of these items were correctly answered by the student. A percentage figure may then be obtained. Of course, even this percentage figure must be interpreted by the teacher. For further discussion the reader is referred to the selected reference list. *Appraising and Recording Student Progress* by Smith and Tyler is especially good.

II Interpretation of data Tests

A. Discussion

The specific behaviors involved in the interpretation of data have been proposed as to how frequently a student was accurate, was too cautious, went beyond the data, or was in error. To better understand how the proposed tests can measure these behaviors, study the chart below.

Teacher's Key

		T	PT	I	PF	F
	T	Accurate	Beyond Data	Beyond Data	Error	Error
Student's	PT	Too Cautious	Accurate	Beyond Data	Error	Error
Answer	I	Too Cautious	Too Cautious	Accurate	Too Cautious	Too Cautious
	PF	Error	Error	Beyond Data	Accurate	Too Cautious
	F	Error	Error	Beyond Data	Beyond Data	Accurate

Again, a percentage figure may be computed for each behavior.

III Nature of Proof Tests.

A. Discussion

The behaviors associated with the nature of proof have been proposed as the frequency with which a student accurately appraised the relevance of arguments and distinguished between facts and assumptions offered as proof.

To better understand how the proposed tests can measure these behaviors, study the chart below.

Teacher's Key

		F	f	A	a
	F	Accurate	Failed Relevance	Failed to Distinguish	Failed Both
Student's	f	Failed Relevance	Accurate	Failed Both	Failed to Distinguish
Answer	A	Failed to Distinguish	Failed Both	Accurate	Failed Relevance
	a	Failed Both	Failed to Distinguish	Failed Relevance	Accurate

Once again, a percentage figure may be obtained for each behavior.

Selected References

For convenience the references are indexed as shown below. Each reference named may not be devoted entirely to the subject heading under which it is listed, but it may contain important relative sections. A few references are repeated under more than one heading when appropriate.

Books

Books Relating to Critical Thinking in General.

Books Relating to Critical Thinking in Science.

Books Relating to Tests, Test Construction and Statistics.

Magazine Articles

Magazine Articles Relating to Critical Thinking in General.

Magazine Articles Relating to Critical Thinking in Science.

Magazine Articles Relating to Tests, Test Construction and Statistics.

Books Relating to Critical Thinking in General

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KEYS

Application of Principles

Physical Science	Biological Science
1. T	1a. T
2. T	2a. T
3. F	3a. T
4. T	4a. F
5. F	5a. T
6. F	6a. T
7. F	
8. T	1b. F
9. T	2b. F
10. T	3b. F
11. F	4b. T
12. T	
13. F	1c. T
14. F	2c. F
15. T	3c. F
16. T	4c. F
17. F	5c. T
18. F	6c. F
19. F	7c. T
20. F	8c. T
21. T	9c. F
22. F	10c. F
Conclusion No. 1	11c. T
	12c. T
	13c. F
	14c. F
	15c. F
	16c. T
	Conclusion No. 4

Interpretation of Data

Physical Science	Biological Science
1. T	1. T
2. PF	2. PT
3. F	3. PT
4. I	4. I
5. I	5. F
6. PF	6. PF
7. PT	7. PF
8. F	8. I
9. I	9. T
10. T	10. I
11. PT	11. PT
12. I	12. I
13. PF	13. PF
14. I	14. PF
15. PT	15. I
16. I	16. PT
17. T	17. T
18. I	18. PT
19. PT	19. I
20. F	20. T
21. PT	21. I
22. PT	22. T
23. I	23. I
24. PT	24. PT
	25. I
	26. I
	27. T
	28. I
	29. T
	30. I

Nature of Proof

Physical Science	Biological Science
1. F	1. F
2. a	2. A
3. f	3. f
4. a	4. F
5. A	5. a
6. F	6. a
7. F	7. A
8. a	8. F
9. A	9. A
10. F	10. a

11. A	11. a	23. A	23. a
12. f	12. F	24. A	24. F
13. F	13. f	25. f	25. f
14. A	14. A	26. F	26. A
15. f	15. f	27. a	27. a
16. F	16. f	28. F	28. a
17. a	17. F	29. F	29. f
18. A	18. a	30. A	30. F
19. F	19. a	31. f	31. a
20. f	20. F	32. f	32. f
21. F	21. F	33. A	33. F
22. a	22. A		34. a

A DISCUSSION OF THE PROBLEM OF MEETING COMMON COURSE REQUIREMENTS BY EXAMINATION

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THE PROBLEM

All undergraduate students in Colorado State College of Education are required to pursue a curriculum, in meeting requirements for graduation, which includes a series of subjects known as the General Education group, or common courses. These requirements are to be met in the junior college years and among them are two courses in the sciences called Introduction to Physical Science and Introduction to Biological Science. More detailed content of these courses can be obtained by reference to the book, *Science in General Education* by McGrath and published in 1948 by Wm. C. Brown and Company, Dubuque, Iowa. This reference gives on outline of the essential areas covered, although the courses as actually taught undergo a continuous modification in content, order, and method of presentation.

Because these courses are designed as a part of the General Education program, let us define "general education" to mean "education for all, regardless of special interests or major fields of study." The content is related as closely as possible to everyday experience, and is presented in as interesting a way as possible by use of current references, discussions, demonstrations, and visual aids in an attempt to help students become better informed citizens.

No doubt many schools face the problem, as we do at Colorado State College of Education, of whether or not general education requirements may be met by examination. The subject matter areas used in these courses in science are on the level of college freshmen, and many freshmen have had little or no science; so for them these courses can be rather difficult. However, there are other students who have had considerable high school science, and for them the subject matter content may be somewhat easier and perhaps more interesting.

Remembering that the content in these subjects is somewhat a means to other ends, the question of meeting the course requirements by examination arises. We use the subject matter content in an attempt to teach scientific attitudes, to demonstrate the scientific method, and to emphasize the logic and order of science. We also try to give students a vivid realization of the way science has benefited humanity in the improvement of our way of living, in giving us better health, and in the promotion of a high standard of living.

The question as to whether or not anyone should be excused from general education requirements on any basis may be raised. The answer to that question is difficult. If it were possible in any concrete way to prove whether or not the

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objectives of the courses, other than subject matter mastery, were being attained to any degree, it might be easy to answer. Not being able to prove that we who instruct can change attitudes, can promote the growth of an appreciation of science and cause students to learn and use the scientific method and to do scientific thinking, it hardly seems right not to provide a way of meeting these course requirements for those who are well informed in the subject matter.

To test some of these more or less intangible results is difficult if not impossible by means of pencil and paper tests. The question resolves itself into whether students make gains which are not measurable in a concrete way, and if they do, is it sufficient and important enough to ask students to sit through a quarter's work covering subject matter with which they are familiar. Perhaps there is no known right answer to this question, but at Colorado State College of Education we are working on the basis of allowing students, who wish to try, to take exemption examinations. They are excused from the science requirements if the tests are passed with scores equal to a grade of B or better as compared with students who have taken the courses. In this way, students who qualify for exemption are able to use their time in chosen major fields or to take some preferred elective courses.

This method of excusing students from general education requirements in science has raised the problem of whether or not the matriculation tests, or parts of them given to all freshmen, could be used as the basis for excusing students from the course requirements or whether the basis should be a comprehensive examination over the course and based upon specific subject matter such as that found in the final examination. In other words, should we use a form of our final examination.

All students entering Colorado State College of Education as undergraduates are given a battery of tests as part of their matriculation requirements. Among these tests is one measuring achievement in the field of science. For experimental purposes, in several recent quarters, the students enrolled in the above mentioned survey science course, Introduction to Physical Science, have been given a test at the first class meeting of the quarter which has generally been called the pre-test in the science course. It has been given, not only to determine the knowledge which each student has of the subject as it is taught, but as the basis for excusing those students from taking the course whose scores were exceptionally high.

The pre-tests have been revised several times and have been rather carefully worked out so as to be reasonably valid and reliable. They are in a form to be answered on separate answer sheets for machine scoring.

This study attempts to help in answering questions which have been raised regarding the value of giving both a matriculation test in the sciences and a pre-test in the physical science course. Could students be excused from the science course at the time of registration on the basis of the matriculation tests in science? Would it be profitable to give the pre-test used for the science course as a part of the matriculation battery? Do the results on the two tests mean much the same, even though the pre-test deals partially with scientific attitude and ability to evaluate data, and partially with subject matter included in the course; while the matriculation test in science uses principles and concepts from the entire field of the natural sciences with a section devoted to comprehension and interpretation of reading materials in the scientific field.

The study upon which this article is based was made to meet the requirements of a designated paper in a graduate course in education at Colorado State College of Education, and presents the facts and data as found by careful statistical work.

PROCEDURES USED

The matriculation test battery consists of the American Council on Education Psychological Examination for College Freshmen; The Cooperative English Test, single book edition, higher levels; and The Cooperative General Achievement Tests. The latter tests cover the fields of the social studies, natural sciences, and mathematics. Each of the tests in the battery is correlated with the physical science pre-test. This is done to determine if any other factor besides achievement in the sciences might have a substantial relationship with scores made on the pre-test. Data is also presented on the predictive value of the various tests with regard to the final grades assigned for the course. In the study, the percentile rank equivalent was also worked out for the scores made on the pre-test, although that data is not presented in this discussion.

The students whose scores were chosen for this study were enrolled in the physical science courses during two quarters of the year. In each case, all students on whom data was available were used in each computation. Some students had incomplete records, so they were included where possible and eliminated only when necessary. In computations involving final grades, only those students taking the physical science course during the first of the two quarters could be considered because the second quarter had not been completed.

TEST CORRELATIONS

1. The pre-test in the physical science course and The American Council on Education Psychological Examinations.

The Psychological Examination yields three scores: the Q, or quantitative score; the L, or linguistic score; and the Total score for the test as a whole. The correlation between the pre-test and the Q score, based upon 414 cases, was found to be $+.39$ with a PE of $\pm.03$, with a critical ratio of 8.605.

The correlation between the pre-test and the L scores, also based upon 414 cases, was found to be $+.45$ with a PE of $\pm.03$, and with a critical ratio of 10.264. The L score correlated higher than the Q score as evidenced by these results.

The correlation found with the total scores of the American Council Psychological Examination and the pre-test was found to be $+.47$ with a PE of $\pm.03$ and a critical ratio of 10.842.

Although each of these correlations is positive and significantly different from zero, it is doubtful if any of them indicates a sufficiently high relationship to warrant the use of any of the scores for this test in lieu of the pre-test for the purpose of excusing students from taking the physical science course.

2. The pre-test in the physical science course with the Cooperative English Test and the Cooperative General Achievement Tests.

The Cooperative English Test has three main sub-tests. They are: Reading Comprehension, Mechanics of Expression, and Effectiveness of Expression. Since the possibility that comprehension in reading could be related to achievement in science, a correlation coefficient was computed between the scores made on the Reading Comprehension sub-tests and the pre-test using 417 cases. This correlation was found to be $+.42$ with a PE of $\pm.03$, and a critical ratio of 8.308. The correlation between the pre-test and the total scores for the English test as a whole was found to be $+.36$ with a PE of $\pm.03$ and a critical ratio of 7.882. Scaled scores rather than raw scores were used in these computations. Each of these coefficients, while not high, is positive and significantly different from zero.

The achievement test in the field of mathematics measures the student with regard to his understanding of mathematical terms and processes, and the ability to comprehend mathematical data in para-

graph and table form. A correlation coefficient of +.60 was found between the pre-test and the mathematics test. The PE was ±.02 and the critical ratio was 14.929.

The highest relationship obtained by correlating scores made on the pre-test in science and matriculation test scores was found with the pre-test and the achievement test in the natural sciences. The Cooperative General Achievement Test in the natural sciences measures knowledge of terms and concepts in the sciences and the comprehension and interpretation of reading materials in the scientific field. Using 397 cases, the correlation is +.68 with a PE of ±.02 and a critical ratio of 18.537. This coefficient, as the coefficient with the mathematics test, is substantially high and significantly different from zero.

The following table summarizes the data:

Test	Coefficient of Correlation (r)	PEr	t	N
1. American Council Psychological Examination:				
Q–score	+.39	±.03	8.605	414
L–score	+.45	±.03	10.264	414
Total score	+.47	±.03	10.842	414
2. Cooperative English Test:				
Reading Comprehension	+.42	±.03	8.308	417
Total English	+.36	±.03	7.882	417
3. Cooperative General Achievement Tests:				
Mathematics	+.60	±.02	14.925	397
Natural Sciences	+.68	±.02	18.537	397

CORRELATIONS BETWEEN GRADES IN THE SCIENCE COURSE AND THE PRE-TEST SCORES

1. Explanation of Grading.

The analysis of student grades was made from the class role sheets for the science course used in reporting grades to the College Records Office.

The College uses a five-point grading system with the marks of A, B, C, D, and F. The marks W and I are also used to represent withdrawal and incomplete, respectively. The grade of A is given to represent superior achievement; B, above average; C, average; D, below average; and F, failure. For the purpose of calculating grade averages, the marks are weighted as follows: A=5; B=4; C=3; D=2; and F=1. The cases where W or I were given, were not used in the computations.

2. Coefficients of Correlation.

Four coefficients of correlation were determined to show the relationship between final grades in the course and test scores. They are summarized in the following table, along with their PE's, critical ratios, and numbers of cases.

CORRELATIONS BETWEEN FINAL GRADES IN SCIENCE COURSE AND MATRICULATION TEST SCORES

Test	Coefficient of Correlation	PEr	t	N
1	2	3	4	5
1. American Council Psychological Examination	+.47	±.04	7.557	202
2. Cooperative English Reading Comprehension	+.47	±.05	7.531	201
3. Cooperative General Achievement Test:				
Natural Science	+.65	±.03	11.888	195
4. Pre-test in the science course	+.69	±.03	11.539	200

GRADE PREDICTIONS

Since both the pre-test and natural science test scores correlated most significantly with final grades in the science course, the regression equation for the prediction of final grades in the science course, when scores are known for these tests, was determined. Using the formula, $\bar{X} = b_{12}Y + (M_x - b_{12}M_y)$, each student's grade was forecast based on known scores for each of the tests. Despite a $\sigma_{(est)} = \pm .70$ when predicting from the pre-test scores, and a $\sigma_{(est)} = \pm .74$ when predicting the grades from the natural science test scores, when letter grades were assigned, the predicted numerical grades were rounded to the nearest whole number.

Each of the pre-test scores made by students in the science course for one quarter was predicted on the basis of the data, and a contingency chart was made to show the comparison of actual and predicted grades for these students.

The following table shows this information when grades are predicted from scores made on the pre-test in the science course:

	Predicted Grades					
Actual Grades	F	D	C	B	A	f
A			5	9	2	16
B			25	24	2	51
C		9	55	15		79
D		16	31			47
F	1	5	1			7
f	1	30	117	48	4	200

Number higher than predicted	48
Number as predicted	98
Number lower than predicted	54
Total	200

(est) = ± .70

This table shows the comparison of actual and predicted grades from the scores made on the Cooperative General Achievement Test in natural sciences.

	Predicted Grades					
Actual Grades	F	D	C	B	A	f
A		2	2	12	1	17
B			23	23		46
C		6	56	15		77
D		17	29	2		48
F	1	5	1			7
f	1	30	111	52	1	195

Number higher than predicted	45
Number as predicted	98
Number lower than predicted	52
Total	195

$\sigma(est) = \pm .74$

PERCENTILE RANK EQUIVALENTS

The 419 scores on the pre-test in the science course were converted into percentile rank equivalent form. Future scores made on the pre-test may be compared with this norm group if an evaluation of the score of a given student in terms of percentile equivalents is desired.

This table is not included here as it is of no general interest.

CONCLUSION

Let us refer back to questions asked at the beginning of this report. They are: Could students be excused from the science course at the time of registration on the basis of the matriculation tests in science? Would it be profitable to give the pre-test used for the science course as a part of the matriculation battery? Do the results on the two tests mean much the same, in spite of certain differences in them?

The correlations with the natural science test of the Cooperative General Achievement group was $+.68$ with a PE of $\pm .02$ and a critical ratio of 18.537. This result is probably not conclusive, although it is positive and significantly different from zero. The results with the other matriculation tests could not be used as the basis for excusing students from the requirement. So we are now using the score on the matriculation tests in achievement in the natural sciences, together with a study of high school experience in the science field and a conference with the student. Often the conference ends with this student deciding to take the pre-test as a final bit of evidence. This choice is now allowed, although at one time for experimental purposes, all students were given the pre-test without choice.

However, several cases have occurred where a student has passed the pre-test with a high enough score to be excused from the course requirement, and whose matriculation scores did not identify him as a possibility. Therefore, although the pre-test is not presently given to the entire class, any who want to try it are given the opportunity on one of the first two days of the quarter, and they are encouraged to try if they have had considerable, recent, high school science.

We realize this is a realistic point of view. Many of us who are teaching believe that a pencil-paper test falls far short of measuring the value of a course. It is felt unnecessary to discuss that phase of the problem here. We, as do most schools, still base our judgment of a student's readiness for advancement in formal education largely on pencil-paper tests.

It will be noted in the results of predicting grades, that just about half of the grades predicted on the basis of both the pre-test and the Cooperative Achievement tests were accurately predicted. Thus for predictive use, one test was about as good as the other, although the pre-test of the science course was slightly better. It is recognized that interests, study habits, general reading habits, and numerous other factors play an important part in the actual results, and that neither test is positively sensitive to those factors.

Since the pre-test in science and the matriculation test in science appear to be somewhat similar in predictive value, it has not seemed necessary nor practical to substitute one for the other. Instead, as noted above, students are now excused from the physical science course requirement on the basis of careful examination of matriculation test results, personal conferences, study of high school records and training, along with the results of the pre-test in the physical science course. It is felt that students who can measure up after considering all of these factors, should be allowed to take work in pure science, such as chemistry, physics, botany, and zoology, or in their major fields, rather than be forced to sit through classes where subject matter is so familiar that little may be gained in scientific knowledge and attitude.

WORKING WITH GIFTED SCIENCE STUDENTS IN SECONDARY SCHOOLS *

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No teacher, particularly in the secondary schools, whose post is in a general school, has failed to contact the gifted student. Quite often this person is referred to as a good student or a fast learner. The usual sign of recognition which the teacher gives on sighting this kind of student species is a low cry or a murmur of approval. Many teachers are understandably certain that this is a rare species, not often encountered. Why some forms of educational environment seem to possess more of this species than other types of habitat is still a question in the minds of many. But it must be pointed out, initially, that the species known as the gifted student quite often assumes a coat of normality and dull plumage. This is probably to assure a longer survival period among the more common species of students. It is also a survival form from the malevolent teacher, another form of wild life, who wants to make certain that this species does not get too many ideas of its importance.

Before this analogy gets too involved, and the point I wish to make is lost, I had best assume a more straightforward approach. I dare not risk analogies in the chemistry field with *this* audience for fear my original point will be completely misinterpreted.

DEFINITION OF THE GIFTED

At one time, the pupil with whom we are dealing this afternoon, was labeled the "superior" student. But it was soon pointed out that the connotation of the term "superior" was distinctly unpleasant after Hitler and his cohorts, and more recently the Stalinist crew, used it to denote their inflated sense of their importance in the scheme of things. The term "gifted" then, is more appropriate, and at least to me, connotes a student who may have some especial abilities in the field under study but not in other fields. The term "good" student does not seem too appropriate either because the gifted student may not show any of the qualities we ordinarily associate with the term good student. In fact, he may be very poor in his ability to study in the usual sense of the word.

Just who is the gifted student in the general secondary schools? Is he ranked by his IQ? Is he judged simply by his performance in a given subject? Is there an aptitude test which delimits him? At the risk of approaching this problem in a rather unpedagogical manner I shall delay, or at least not settle upon, a hard and fast definition of this person. Rather, I shall propose a tentative hypothesis to define the person with whom we are concerned, and then tell of the work and the results which have occurred after using this tentative statement. We know the gifted student exists; we know the gifted student in science accounts for a great many of the fundamental ideas and techniques used in scientific research and technological work today; we know the gifted student is not simply *any* student who is given a fortuitous set of educational circumstances. This we already know. Yet we do not know the exact limits of the person's characteristics. We must proceed, then, to regard him as a valuable person, and aim for him with our best educational guns, without seeing our target clearly.

The gifted student in many surveys usually has been stated to be in the upper 1%, or at most the upper 2% of the population, either in IQ or in an aptitude test that is given. If that is the limit of the group with which we are working, then while we should not neglect them, there seems to be little reason for an elaborately organized program for them, especially in

* Special Lecture delivered at the Institute for the Teaching of Chemistry, St. Louis University, July 1, 1953.

the small school. But we do not know who this 2% is in the secondary schools, and our methods of measurement are too inaccurate to delimit them so early. We must start in the secondary schools with the upper 10%. Dr. Paul Witty, a student of some distinction in this problem, has agreed with this suggestion as proposed by Dr. Henry Viets of Harvard. With this definition we at least allow some reasonable margin of error for our tests, as well as for the margin of time the potentially gifted may take to display themselves. It must be reiterated, almost ad nauseam to the Fullerites who demand subject matter retention regardless of age, that the student in the secondary school is in a phase of physical and mental growth that is still largely uncharted. Vast and cataclysmic changes occur regularly in the mental and physical lives of these children. The readiness factor in science learning is not regulated by the classroom bell. The immature student of one year in science, with little promise, may become the intensely interested student the next, with great potential—because of the subject or teacher? Perhaps, but it could easily be because of his mental preparedness for the types of learnings demanded.

Our definition of the gifted student, then, will include the upper 10% of secondary school pupils in the general school. The upper 10% may be delimited by the usual psychological tests, or by academic achievement, the grades already made in the school career. With tests there is always the margin of error to reckon with. With grade records, the readiness factors may cause some margin of error, or the inadequacies of the grading system may account for the error which may creep into our placing students in the upper 10%.

IDENTIFICATION

The identification procedure, then, which I propose, is a very pragmatic one. It is tentative, because as teachers we are feeling our way along in identifying the truly gifted student. Let us assume that whatever our first contact is to be, as science teachers, with the secondary school student, we do, at least, two things. First, we use the best tests we can to determine the upper 10% of our given group. Second, when these students appear in a science class we watch for the upper 10% insofar as their grades in science indicate them. With these two groups of students ranked in the upper 10% of our given group by the two methods, we should have, conceivably, a great deal of overlapping. Those which remain in one of the two groups, but not both, should be judged on their potentiality in science. If these express an interest in science to the extent of majoring or minoring in it they should be placed in our already selected group. If they express no interest in science, or have not decided on any course of major interest, they should be placed tentatively, and only with the approval of all concerned, in a science gifted group. Then as a terribly long shot, the very small group of students, who academically and by tests show that they are not in the upper 10%, but whose achievement in science by projects, equipment construction, or hobbies, indicate some technological success, should be invited to be in the group which we have delimited.

SEGREGATION

With this core of students chosen on a tentative basis, and as the result of our best methods of identification, our next problem is what must and should be done with their science education. With this tentative identification, the process of elimination begins when other interests capture them, or when their achievement in the sciences no longer is adequate. This elimination is performed by the students as well as by the teacher. When a pupil outgrows the educational clothes we have designed for him, he will be exposed in the end. Identification is a continuous process, and segregation of the *potentially* gifted becomes, as time continues, the segregation of the *really* gifted. One pupil may show an

immature attitude, but adequate grades, in his first few years. But in his senior year his readiness factor becomes apparent. While we do not retain all the 10% we segregate, we do give them the best we have in science teaching, and we hope to awaken them so that they may identify themselves to themselves. The gifted are always in danger of seeing the easiest and most immediate way out of any situation with no challenges to their mentality. Some never do make up their mind. The system of thought with no abiding interests, no work, no mental stimulus, built up in high school, becomes a permanent characteristic. These become the floundering, appalling waste of brain power in this country.

One of James Thurber's cartoons shows an irate woman talking to a very small boy, "Are you the young gentleman that bit my daughter?" In dealing with the gifted we often forget that in the secondary schools they are still children. While I will not argue that the gifted should have the same treatment given every other child in educational techniques, I will insist that many of the techniques preached about for the improvement of science teaching is applicable in dealing with the gifted.

One of the exceptions to this general rule of using the best methods of science teaching is the segregation of the gifted. In my school we have no science in the 9th grade, and thus the science teacher first comes in contact with most of the students in the 10th grade biology classes. After one semester in the unsegregated groups, we choose the upper 10% on the bases which I have already indicated. We do not obtain all who should be in segregated class, but we do obtain a class, the enrollment of which is forced by school crowding to the same size as the average biology class. This segregation continues on a different basis in the 11th grade chemistry and the 12th grade physics class. There segregation is rather automatic. The upper 10% in the biology class will usually register in these classes, a very small percent from the other biology classes, and a few without the biology background. Thus the type of student in chemistry and physics is automatically in a higher group. The senior physics classes become the cream of the science crop. The median IQ in the physics class has become 115 as compared to the biology's 101. While this shows the high calibre of the physics group it also indicates the necessity of another course, physical science, to take care of those who have fallen by the wayside.

Segregation, whether intended or automatic, has many advantages in dealing with the gifted. It permits enrichment of the course by devices, highly impractical in the average class. It serves to offer competition for the gifted which they may never obtain otherwise. To avoid the designation of "teacher pet" the gifted may actually soft-pedal his learning activities so that he does not stand out too conspicuously. It must be remembered that we are dealing with adolescents, one of whose prime characteristics is to merge himself with a larger group. If they are placed in a segregated group where the general rule is a high level of achievement, they are not discouraged by the terrifying thought of being different. This is a real fear. I cannot imagine a male pupil in our school wearing his belt at any level higher than the lower three sacral vertebra of the spinal column. To a slim hipped fellow this must present a big engineering problem.

With segregation there must be some allowance for a grading system that is comparable in difficulty with the system used in the regular science classes. If the segregated class has stiffer requirements than the average class, the gifted will not wish to be included. Remember, they are still children. After all, they are well aware that colleges still consider an "A" to be an "A" regardless of the type of class.

ENRICHMENT

But simple segregation is not enough. The segregated group must be given the type of instruction which it is now fashionable to call enriched. This takes several

specific forms: 1. special speakers, 2. special field trips, 3. advanced reading materials, 4. more experimental materials and requirements, 5. lectures on the current developments in science, and 6. talks by every other science teacher in the school whose special fields relate to the units under consideration.

It is obviously impossible to get a line of speakers to talk to all the science classes at any one time, and the value will be questionable for the majority of the students. But few persons in science will turn down an invitation to speak to such a select group. We have had professors from universities travel 60 miles for the purpose of addressing this group. They were willing and happy to return.

When it is impossible to take a large and perhaps disinterested group to a local hospital or research laboratory, the segregated group becomes an easily manageable group, whose conduct will be exemplary, and who will seem to obtain much from the trip as can be seen by their conduct and their questions.

We insist that the segregated group have access to materials which are on the college level. There is no thrill to a teacher like the thrill at seeing a considerable number of students in the library and in class reading college textbooks which were not assigned, nor even particularly urged upon them.

The segregated group can have its paper and drill work cut down considerably. Usually they can comprehend the spoken and written word more quickly than the average group. The time saved by the elimination of much repetitious drill work can be used for project activities as well as the special speakers.

One of the resources within a school, often neglected by the science department, are the other teachers in the school who have some specialty which pertains to the unit under study. There is not only flattery to the teacher, but there is an opportunity to establish the rapport between student and teacher which may have only, to that point, depended on gossip. A teacher who may have an earned reputation for toughness can do much to allay this talk by his appearance in an informal question and answer period. Here is the chance for the teacher to sell his subject, and few ever muff the chance.

INDIVIDUAL INSTRUCTION

One of the principles of good teaching hammered home in most of the education courses I have taken, although I must add seldom practiced in such courses, is that the individual child is of prime concern. This axiom is that instruction should be individualized. This is doubly true with the gifted. They learn differently than the average child, and thus their instruction must be tailored accordingly to obtain the maximum learning in the shortest time. Also, the scientific method is best taught by using it in the class, and this means individual projects, experiments, and activities.

The gifted must be approached as individuals, as you soon will discover they are. If, in your judgment, they need more emphasis on reading, or questioning because of a passivity in accepting all that is told them, or oppositely, a curb on conclusion making before adequate data is accumulated, or more experience with equipment manipulation; then, as the teacher you must take this person, keen as he is, and help him remedy his faults.

My role in this process can be separated into several steps. I attempt to arrive at some tentative judgment or diagnosis of the student and what I think he lacks, as well as what he possesses in favorable measure. Second, I attempt to inform him gently of some of my tentative opinions. Third, I make sure that he understands that I have a genuine interest in his personal and educational progress. I have seen many teachers who are afraid to let the students know of their interest in them as individuals. Fourth, I try to attend as many meetings, events, and field trips as possible, and to invite the student who may

be interested in this type of meeting. Lastly, I hunt for the community resources available for the student with some especial interest, and then introduce him to the places and persons.

At the risk of being trite, may I reiterate a cardinal principle in my teaching creed; viz., teaching is like selling. The salesman must know his product, and his potential customer. He must find out *how* what he has to sell will benefit the customer, so that the customer will be encouraged to find his own resources to gain the product. The product we sell is intangible, but real; the customer is rich, but tight. It calls for enthusiastic salesmen. To the gifted the cost of the product is not as important as its attractiveness, durability and the chances it offers for future development.

ADVANCED COURSES

The gifted student should be permitted by curriculum offerings to take advanced courses in the sciences. Perhaps, crowding and scheduling difficulties seem insurmountable odds to overcome with new classes with tiny enrollments. To the interested teacher, even this is not impossible. Our physics teacher found two in the gifted group who were anxious for further instruction. He arranged their program so that they would be assigned to him during one of his regular classes. They did much in reading, working experiments, and coming in after class for further instruction. Is there any really valid reason why a science teacher should shirk the responsibility of slaking the thirst of such students? From such small beginnings advanced courses have developed. We now offer Biology III, Chemistry III, and Physics III, and sometimes, Chemistry IV.

We have a big question about this, however. What will the colleges do with these students? Will they run them through the undergraduate grinder, regardless of background? Will they put them in advanced courses so that they will save time, but receive the same credit with much more work? We believe that our students will retain much of their enthusiasm for science, and obtain much advanced instruction by advanced courses. But we fear for his treatment in the hands of an undergraduate instructor who feels that his prerogatives of teaching certain material has been usurped by the secondary schools, and consequently will be primarily interested in contradicting much of what the student thinks he knows. One survey shows that 14% of the high school seniors surpassed in general information and intelligence the average college senior of 21 years of age.

PITFALLS AND DISCOURAGEMENTS

I would not want you to think that plunging into a program for the gifted will turn out to be easy, or even rewarding at first. Many teachers believe that working with the gifted will be easy, because he does not require as much trouble as the dull normals, is more responsive, and is self-propelling in his educational progress. These are deadly fallacies.

You must sell the administrator who offers a myriad of reasons why the program is impossible. You must convince other teachers that their classes are not being robbed of talent, or that the gifted are not being given an exaggerated sense of their importance. Encourage the student to find an advisor for his science career and work among these teachers; always take the regular classes yourself, and much of this trouble is avoided. The gifted will be the easiest to convince, but they must not be held apart from the entire school the entire day, or they will feel the stigma which they all fear.

Students will change their majors after you have spotted their potentiality. The student with high promise may collapse in interest and in grades. Perhaps his pleasing personality fooled you. When the science work calls for different skills, some of your potentials will degenerate into mediocrities.

But never give up the task of selling and encouragement. Discover all the science contests, fairs, and awards. Encourage the

entry of your students. They will win, and the results will be as valuable as the win and loss record is to the basketball coach looking for a job.

In the national science awards contest this year in which I acted as a judge, among the 11th and 12th grades entries only one-third concerned chemistry, and only two of these displayed what the judges labeled as student ingenuity. The rest were taken from college textbooks. It is in chemistry that there seems to me a great field for more stimulating teaching. To be sure we have developed excellent chemists, but in my opinion, it is in high school chemistry where the smallest proportion of the science talented are retained. There needs to be more tieup of chemistry with the other sciences on the high school level.

LESSONS

Some of the lessons I have learned in dealing with the gifted can be listed under these headings:

1. The gifted child appreciates and understands remarkably well the theoretical and abstract approach. Science fiction, remember, has many readers as well as authors in the scientists' group. In cell division, we spend some time in analysis of the current theories used to explain some abnormal cell division, or cancer. What if some of the class is lost? Perhaps one or two understand and are intrigued enough to go further. If they discover the cure for cancer, was our time wasted? In biology we must take up some very elementary chemical concepts. We do it on the blackboard rather than by demonstration and most of the gifted grasp it quickly.

2. Every gifted student has some weak spots which they should be made aware of and which the teacher should assist to strengthen. For example, spelling is a weakness for some of the gifted. This can be disastrous. In the same science contest, about which I just spoke, one contestant told about how he roped his teacher into helping him. The trouble was that the word roped was spelled with an "a".

3. Memorization is a frequently found ability in the gifted. This could be the beginning of some bad habits, it seems to me. They tend to find out what the teacher wants, memorize it, and loaf the rest of the semester. They lose the questioning attitude which I believe they should possess in good measure. We had a student turned down, we discovered, for a Rhodes scholarship because he never registered opinions about anything, although his vast learning was undoubted. He never had to think because he memorized rapidly, and never questioned what he read.

The scientist must have a critical attitude, even in the chemistry class. My experience with chemistry has been that the elementary phases of that science are so thoroughly worked out that experiments for student use allow for no questioning attitude because things fall so beautifully into place. I believe the chemistry teacher should work overtime in encouraging this critical attitude, because it is most likely to be smothered in the chemistry class—and this in the class which has the widest range of possible experiments. I realize that a student may very well question too radically in chemistry and end up as the familiar spot on the ceiling, but I will stick to my original contention.

4. Busy work is anathema to the gifted student. One student I had seldom turned in drawings which the biologist feels to be so necessary. I tried to explain the necessity of drawings, but bargained with him that I would accept a better method if he had it. He soon turned up with beautiful photographs which soon progressed to a professional standard. Another student who had ranked at the top of his class in his five years in pre-medical training, and is now on a Fulbright award, studying physiological chemistry at Cambridge in England, while in high school, liked to write out the answers to questions, to outline, and to verbalize his work in science.

Much of this I considered busy work but it soon dawned on me that this student had discovered how he learned and memorized. To many other students, this is totally unnecessary. They see much as repetitious work and it quickly dilutes their interest. What is worse is the attitude which often develops that doing such repetitious, unstimulating work is what is meant by study.

5. Self-evaluation is appreciated by the gifted. They like to know what you are testing for so that they may judge themselves. The point system is useful for this because the student can see how he ranks with the other members of the class, even though their grades may be the same. How far this can go I discovered last month when I uncovered a betting pool on each test. Each one in the pool contributed 5¢ per point between his grade and the highest grade in the pool. The pot then went to the highest student. Each student felt his intelligence to be as good as the next fellow's, and he was willing to put up the money to prove it.

6. There is a continual battle for the primary interest of the gifted student. They often excel in other fields. Which is the most attractive—not the easiest—is the question they are always deciding. Athletics ranks as number one contender for their interests. Terman pointed out that the gifted are also superior physically. What coach would not drool over a fine physical specimen with brains?

7. Some of the gifted like the authoritarian approach to teaching and others disdain it. But both appreciate the confidence the teacher shows when freedom is permitted. Once, upon returning to a class which I had hurriedly left, I found a student leading the discussion with everyone's consent. I had made no previous plans for this eventuality.

8. The gifted will investigate on their own, and often quite independently of the teacher. It is a joy to see the students in any class reading the material not assigned, yet this is the usual occurrence among the gifted.

THE FUTURE

I. The future seems to me to hold a growing insistence in science teaching for the differentiated curriculum for the terminal student and for those planning a science or technical career. While the value of this may be questioned in other fields there is much to affirm it in the sciences.

II. A physical science course consisting of physics and chemistry seems inevitable. Just as the biologists are proud of their name, now, the physicists and chemists will become proud to be called physical scientists. I would propose a year of such physical science in the freshman year in high school in lieu of the usual general science. Biology should no longer be taught as an observational nature study course; it needs some physical science background. It is more meaningful when the student has had it. Every new freshman college biology text I have seen begins with at least two chapters on this background.

III. Laboratory work can no longer be stereotyped and routine to the point of dullness. Experiments must be experiments in the student's mind. If they are not, he will memorize the answers from the book, and what is the difference if he does under those circumstances?

IV. There will be more award contests and recognition for science achievement. Do not let sniffy ideas of the ivory tower prevent your encouragement. They are as valuable as athletic contests. There are some dangers, but they are not yet real.

V. Projects for the gifted student are a necessity. They become a binding force in his science work. One of our students in tissue culture work found in his first year of medical school that he was in the unusual position of teaching the faculty some techniques that he had learned. Projects will be the cords which tie up for the student his scientific knowledge.

CONCLUSION

The productivity ratio produced from the data collected by the Washington University School of Management indicated

that 2% of our population produces 85% of all our tools and procedures. We know of the shortage of scientific and technical personnel; we know that most scientists started in science in the secondary schools; we know there is a great difference in the learning powers of the student. But do science teachers realize the implications of this knowledge?

Society has been revolutionized by the results of science. But the scientific method which produced these things has not been made clear in the minds of the layman. We see the importance of the *method,* but in science teaching we continually flaunt this method. We teach the class so that the average, intelligent student will grasp our meaning, and we neglect the gifted who are already ahead of us with their comprehension of what we are saying.

Among other results, the real, terrible result has been the drifting apart of society and the scientists. Society puts up with science but disdains and distrusts its techniques. Even the fortune teller, using the crystal ball, uses Windex to see the picture more clearly.

When science teachers see the implications of all this, then they will begin the job of salesmanship of new methods of science instruction of which they are capable, and this will necessitate a different and specialized type of teaching. If the gifted student does not receive this, his educational opportunity is not that of the average student, but actually inferior. We aim for the average and thus the average student is given our best instruction. The gifted deserve equal educational opportunity.

There is a terrible urgency about our work. In our race for world survival, our procreative ability, our past achievements, will not be enough. We must use our human resources to their maximum. We are lagging in the technological race. We must be willing to be radical in our solutions of the problems of low scientist output and the poor understanding of science by society.

The gifted 2% will come from the upper 10%. You cannot ignore them. They are the persistent fact in science teaching today. What are you prepared to do about them?

ARE SCIENCE FAIR JUDGMENTS FAIR?

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INTRODUCTION

For several years New England's science teachers have been running science fairs. They have selected the winners by judging them, based on a set of fairly uniform standards on a score card. Many times, trained and experienced judges have achieved remarkable agreement among themselves as they selected the winners. Unfortunately, trained and experienced judges are not available in sufficient quantities, for the fairs have grown in large numbers recently. As a result of the great demand the supply has come from inexperienced but willing science teachers whose judgments may not be as reliable as may be desired.

Recently at our large local science fair our committee was fortunate in being able to obtain a large number of judges. In all, twenty-one judges participated in judging our fair. Of this group eighteen were known to be experienced science fair judges and science teachers. The remainder were young "practice-teachers" in science education or inexperienced judges of fairs. As the scores were tallied and the rankings were established it was noticed that there were wide variations in project scores

CHART I

PROJECTS AND THEIR SCORES

Junior Division

Judges Scores

Project #	High	Score	Medium	Score	Low	Score	Average Score	Range Score
1								
2	G	48	D	43	L	42	44	6
3	H	87	I	81	G	47	69	40
4			M	79	K	41	55	38
5	I	66	G	48	K	34	49	32
6	I	86	G	60	K	30	65	56
7	H	74	N	60	G	43	52	32
8	I	82	G	39	K	33	44	49
9	I	76	G	46	K	40	54	36
10	H	64	N	54	K	42	53	22
11	J	58	P	41	Q	43	40	18
12	J	60	Q	39	P	30	43	30
13	J	36	P	29	Q	17	27	19
14	J	40	P	32	Q	28	33	12
15	J	57	P	32	Q	21	34	36
16	J	59	P	52	Q	36	49	23
17	J	61	Q	56	P	37	51	24
18	J	57	Q	50	P	45	50	12
19	H	75	P	56	J	42	57	33
20	I	65	R	31	S	29	41	25
21	R	51	T	50	S	18	39	33
22	T	55	R	38	S	22	38	33
23	T	72	S	28	R	26	42	46
24	H	69	T	45	S	15	43	54
25	T	48	R	31	S	23	34	25
26	P	65	J	60	S	38	54	27
27	H	84	I	79	R	78	80	6
28	H	73	R	66	N	56	65	17
29	U	53	N	47	R	42	48	11
30	V	35	N	30	R	28	31	7
31	R	60	L	37	S	23	30	27
32	V	70	U	60	R	47	59	23
33	U	75	I	71	R	50	65	25
34	R	85	I	81	U	69	78	16
35	N	71	H	45	R	27	47	44
36	N	75	H	75	R	69	73	6
38	V	58	W	33	R	28	39	30
39	W	47	V	34	R	32	37	15
40	M	69	W	53	R	25	53	44
41	V	86	W	72	R	56	67	30
43	M	69	W	55	R	55	62	14
44	M	69	W	53	R	37	54	4
45	V	43	R	28	W	23	31	20
46	U	75	V	74	D	61	70	14
47	U	55	O	54	V	51	53	4
48	M	68	U	55	L	28	55	40
49	W	46	U	45	L	28	31	18
50	U	75	W	52	L	40	55	35
51	M	81	W	70	U	21	62	41
54	O	72	M	54	L	37	47	51
55	U	75	W	72	L	30	62	38
56	U	60	W	37	L	30	42	30
57	O	42	D	41	L	26	36	16
59	L	65	U	34	N	14	37	51
61	E	78	M	53	T	40	55	38
64	T	62	O	60	M	54	58	8

Average Score 49
Average Range 27
N 55

CHART II

PROJECTS AND THEIR SCORES

Senior Division

Judges and Scores

Project #	High	Score	Medium	Score	Low	Score	Average Score	Range Score
69	D	30	M	24	G	5	19	25
70	U	49	M	46			47	3
71	V	85	M	66	U	60	70	25
72	M	61	V	57	G	53	57	8
76	R	77	G	63	B	45	61	32
78	O	71	E	66	2	37	58	34
79			O	40	B	20	30	20
81	O	46	2	29	B	15	26	31
82	2	73	8	64	O	64	67	9
84	O	79	2	55	E	51	61	28
85	2	57	O	44	P	41	47	16
88	E	40	2	32	O	32	34	10
90	P	49	J	48	L	35	44	14
91			N	46	B	36	41	10
92	O	54	P	51	J	49	51	5
93	P	66	O	61	J	52	59	14
95	O	96	P	68	J	65	76	31
96	S	86	J	71	P	61	72	25
101	J	40	N	36	S	35	37	5
102			S	49			49	
103	G	69	S	67	A	34	56	35
104	2	84	S	75	G	58	72	26
105	N	75	S	66	D	65	68	10
106	U	25	D	19			22	7
107	T	58	S	32	R	28	39	30
108	T	32	S	26	R	17	25	15
109	O	58	D	40	V	24	40	34
111	V	80	R	44	A	39	54	41
112					R	46	46	0
113	G	75	O	57	D	53	61	22
114	L	56	M	56	R	47	53	9
115			2	40	W	7	23	33
116	T	76	V	70	W	67	71	9
119	T	75	V	75	W	56	68	18
121	T	85	G	68	W	61	71	24
122				25	W	19	22	5
123	T	86		86	G	58	76	28
126					E	45	45	
129	M	88	R	86	E	60	78	28
130	M	52	R	36			44	16

Average Score 50
Average Range 18
N 41

among many judges. The inconsistancies were so great that it was apparent that the winners had been established by a method that was open to serious criticism. It was observed that the judgments had neither reliability nor validity.

PROCEDURE

A study was made of the judging results in an effort to discover any generalities that might lead to a solution of the problem of the many inconsistencies which were present.

A record was made of the scores of each project. Letter symbols and code numbers were substituted for the judges' names and for the contestants' names. This record has been identified as Chart I and Chart II. The scores were averaged and the range of scores of each project were recorded. From these average scores and the indi-

vidual ranges the average range of the judgments rendered on the projects in each division was determined. This procedure revealed the extent of variation in scores of the projects and the data were listed in Chart III.

CHART III

EXTENT OF VARIATION IN SCORES

The extent by which the Judges' variations in scores exceeded the average ranges of scores of all projects.

In the Senior Division consisting of 41 projects:

46 percent exceeded the average range of all projects.
17 projects exceeded the average range by 5 points.
13 projects exceeded the average range by 10 points.
4 projects exceeded the average range by 15 points.
1 project exceeded the average range by 20 points.

In the Junior Division consisting of 55 projects:

48 percent exceeded the average range of all projects.
20 projects exceeded the average range by 5 points.
11 projects exceeded the average range by 10 points.
8 projects exceeded the average range by 15 points.
5 projects exceeded the average range by 20 points.

The next procedure consisted of recording how many times a judge in scoring a project, also scored by two other judges, scored the project higher, the same as, or lower than the other two judges. This procedure revealed the tendency of a judge toward being a high, medium, or low scoring judge with or without any consistency in scoring. This has been done in Chart IV.

CHART IV

ANALYSIS OF THE JUDGES SCORING CONSISTENCY

The Judges	Number of times this judge scored the:		
Code Letter	Highest Score	Medium Score	Lowest Score
A	0	0	2
B	0	0	4
D	1	3	3
E	2	1	3
V	7	5	2
G	3	6	6
H	7	1	0
I	6	4	0
J	9	3	4
K	0	0	6
L	2	1	9
M	8	7	1
N	2	6	2
O	8	6	2
P	3	9	5
Q	3	7	6
R	4	8	18
S	1	7	8
T	10	2	1
U	9	5	3
W	2	9	6

Another procedure was to make a list of the winners showing their average score and the place and the position that they won. Their average score had been calculated by an average of three individual scores. It was observed that if the score that differed from the other two by the greatest amount was removed and a new average score was calculated from the remaining two, then the new average score

might be quite different from the original one and the position that this score might win could be quite different. This was done and the results were listed in Chart V.

CHART V

SCORING POSITIONS OF WINNERS

Score and Position of Winning Projects with Three Scores, and After One Score Was Removed

Project #	Average Score (3)	Position	Adjusted Score (2)	Adj. Position
95	76	3	66	12
96	72	7	66	12
104	72	6	79	2
116	71	5	69	8
121	71	4	64	14
123	76	2	86	2
129	71	1	81	1
27	80	1	78	4
34	78	2	83	1
36	73	3	75	5
46	70	4	74	6
4	69	5	81	2
41	67	6	79	3
6	65	7	73	7

Observations

An examination of Charts I and II revealed that some of the scores deviated beyond the average range so widely that their disagreements were greater than the average scores of the projects. This fact suggested that the judges may have subjectively evaluated different qualities.

The evidence shown in Chart IV revealed Judges T, H, and U nearly always scored higher than any other judge with whom he judged a given project. Judges B, K, L, and R always scored lower than any other judge with whom they judged a project. Judges B and K never high scoring judges, always fall in the middle or low position. Judges H and I were never low scoring judges, always scoring in the high or middle position. Judges J, O, V, H, I, M, T, U, could be characterized by the majority of their scores to be usually a high scoring judge. Judges G, Q, R, S, W could be identified by the majority of their scores to be usually a low scoring judge. There remain only four judges of the twenty-one who could not be characterized by their judgments as being either a high scoring or a low scoring judge. This is only 13 per cent of the judges in the entire fair.

It can be observed by examining Chart V that if one score were removed from the three that constituted the average score for the project, that in all but two cases the winners would lose their relative rank and would become a different rank winner or would not be winners at all.

All these data strongly suggests disagreement among judges concerning the factors they were measuring and the quantitative evaluation leading to unreliable judgments and invalid aggregated scores and winning position.

An examination of the current and generally accepted score card was performed to discover if there were weaknesses in it which would result in unreliable or invalid judgments. A probable cause of the judges' wide variations was discovered here. The score card with its standards for judging has been included as Charts VI and VII. It was noted that the standards were not rigid and definite and that large score units were assigned to each item that was judged. A meticulous and careful judge interpreted narrowly and scored low on the same item of a project in which a generous judge interpreted widely and scored the item high.

The accumulation of item scores obtained by following these practices accounted for many of the extensive variations in project scores between judges.

CHART VI

SCIENCE FAIR SCORE CARD

GROUP DIVISION

Project number

1. Scientific Approach (30 points)
2. Advancement in Science for Contestant (20 points)
3. Ingenuity in Construction, Technical Skill and Workmanship (20 points)
4. Thoroughness (10 points)
5. Orginality of Concept (10 points)
6. Social Implications (5 points)
7. Dramatic value (5 points)

Total score:

Placing:

Judge's name: ....

CHART VII

SCIENCE FAIR

Standards of Judging

1. Scientific thought: 30 points

The exhibit should show clearly the results of application of the scientific methods to the problem. Particular stress should be laid on the orderly analysis of the problem, its experimental approach, the collection of observations and their analysis. There also should be the clear presentation of the experiment as a coherent whole. Background should be considered.

2. Advancement in Science for Contestant: 20 points

As one of the aims of the Fair is to discover young potential scientists, exhibits should indicate clearly the contribution made to the young scientist's own mental development as well as to the development of his interest in research and to the products of research in science.

3. Ingenuity of Construction, Technical Skill, and Workmanship: 20 points

Neatness of construction and presentation as well as ingenuity in the use and adaptation of every day common materials is important.

4. Thoroughness: 10 points

The exhibit should carry out its purpose to completion within the scope of the problems.

5. Originality of Concept: 10 points

The conception and presentation of the exhibit should show originality and not be copies of known experiments. Obviously, the originality should be commensurate with the grade level of the exhibitor.

6. Social Implications: 5 points

The relative importance of the exhibit and the problem studied to the welfare of man and his society must be shown by the exhibit.

7. Dramatic Value: 5 points

The exhibit should convey its message and results in a forthright manner which will require a minimum of detailed explanations. It must be graphic in its presentation of the problem and its results.

A Suggested Solution to the Problem

Several solutions to the problem were found (in part) in several writings available in the general body of science education literature. The suggestions in the writings of Norman R. D. Jones (5) and current science fair standards as reported in several reports (1)(8) and many other sources

(2) (3) (4) (6) (7) (9) were studied. A valuable suggestion was discovered when a score card published by and used by the U. S. Bureau of Dairying for judging dairy farms and plants was examined. It had many items, but they were delimited, there

CHART VIII

SCIENCE FAIR SCORE CARD

Project Title: Project #

Items for Scoring: All scores are All or None Items

Scientific Methods used in solving the problem	30	xxxx
1. Evidence that the problem evolved naturally from life	2	
2. Evidence that the search for related facts was made	3	
3. Evidence that a hypothesis was developed	4	
4. Evidence that controlled observations were made	5	
5. Evidence that findings were tested for accuracy	6	
6. Evidence that conclusions were limited to data	5	
7. Evidence that credit was recognized in bibliography	3	
8. Evidence that plans exist to share the truth	2	
Advancement in Science for the Contestant	20	xxxx
1. Evidence that there is a new interest in Science	4	
2. Evidence that there is a new scientific knowledge	4	
3. Evidence that there is a understanding of the Scientific Method	3	
4. Evidence that there is a new respect for scientists	3	
5. Evidence that there is a scientific attitude	3	
6. Evidence that this study is of a school year duration	3	
Ingenuity of Construction, Technical Skill, Workmanship	20	xxxx
1. Evidence of all possible use of everyday materials	3	
2. Evidence of precision, order, care, skill in building	5	
3. Evidence of durability, portability and safety features	5	
4. Evidence of no professional assistance	4	
5. Evidence of creative imagination in design	3	
Thoroughness	10	xxxx
1. Evidence that project carries out its purpose	2	
2. Evidence that observations were accurately made	3	
3. Evidence that labeling is clear	1	
4. Evidence of graphic or pictoral illustrations	1	
5. Evidence that it works	3	
Originality of Concept	10	xxxx
1. Evidence of an original idea	2	
2. Evidence of new methods used	2	
3. Evidence of any new apparatus developed	2	
4. Evidence of any new materials used	2	
5. Evidence of any new conclusions reached	2	
Social Implications	5	xxxx
1. Evidence that contestant sees its use today for man	3	
2. Evidence that contestant sees its use tomorrow for man	2	
Dramatic Value	5	
1. Evidence that it attracts people to look closer	2	
2. Evidence that it is self-evident in explanation	3	
Total Score	100	xxxx

Judge's Name..

To Score a Senior High School Research Project do all items.
To Score a Senior High School Exhibit (applied science) and
To Score a Junior High School Project omit A 1, 2, 5, 7, 8.
To Score a Junior High Exhibit or an Elementary School Fair, a popular vote for best 10 of all exhibits by all judges is recommended.

were exact definitions and small scores for each item. A new score card was built in which these many suggestions were incorporated. The card had all the basic features of the old card, but those factors which had caused the wide variations had been removed or revised. It was tried on many projects in several fairs and has proved to be useful, practical and rapid. It was not necessary to further clarify or explain the items, for they are quite self-evident. A copy of this new type card has been included as Chart VIII.

Conclusions

1. An examination of the findings reveals variations in judgments which are so extensive that they could not be called reliable or valid evaluations of the science qualities in the projects examined by the judge nor stated in the standards.

2. The positions which were assigned based on these judgments were dependent on unreliable and invalid evaluations and would fluctuate wildly if less judgments were employed.

3. Judges could be easily characterized as being high scoring, low scoring or medium scoring, consistant or inconsistant, as a result of their scores.

4. A revised score card with more exacting and objective standards and narrower limits has been constructed and offered as an instrument which is believed to help reduce the inconsistancies, variations and poor judgments inherent in the one currently utilized.

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THE INSTITUTE FOR THE TEACHING OF CHEMISTRY

(*Continued from page 188*)

cial lectures planned for this summer include: June 30—"Difficult Concepts in Beginning Chemistry", Dr. Grant W. Smith, Professor of Chemistry and Director of General Chemistry, Pennsylvania State University; July 7—"How Do We Get Scientific Knowledge", George P. Klubertanz, S.J., Ph.D., Assist. Professor of Philosophy and Dean of the College of Philosophy and Letters, St. Louis University; and July 14—"What the Public Should Expect of a Science Teacher", Dr. Hugh C. Muldoon, Professor of Chemistry and Dean of the School of Pharmacy, Duquesne University, Editor of Science Counselor.

Although the Institute is part of the program of the University which leads to the degree of Master of Science in the Teaching of Chemistry, it is also open to high school chemistry teachers who wish to spend the summer in review and further work in chemistry and teaching problems.

Further information may be secured from Dr. Theodore A. Ashford, Director of the Institute.

THE SEARCH FOR SCIENCE TALENT

Samuel W. Bloom
Monroe High School, Rochester, New York.

The annual Science Talent search conducted by the Science Clubs of America and sponsored by the Westinghouse Educational Foundation is now being promoted in schools large and small across the continent. Many schools judge the success of their science programs by the number of winners or honorable mentions that they are able to develop.

In recent years, the scientific organizations such as the American Chemical Society, The Engineering Manpower Commission of the Engineers Joint Council, The National Science Foundation, The American Society for Metals, The American Association for the Advancement of Science, to mention but a few of the many organizations[1] have become concerned with the problem of training enough scientists for the nation's expanding needs. Increasing our supply of scientists is a task that cannot be performed over night. Highly skilled and productive research workers can only be developed by years of rigorous and intensive training. Our present scientific manpower situation is dangerous to our national welfare and security. It is urgent that steps be taken to extend and improve our pool of scientific personnel.

The Science Talent search is one of the means of encouraging the development of scientific research at the secondary school level. Many research scientists today agree that the incentives and inspiration for a scientific career were nurtured in the formative days of their early schooling. The Science Talent search is one way young potential scientists can gain recognition and scholarship assistance for future scientific careers.

[1] Steelman, John R., "Science and Public Policy." A report to the President. U. S. Government Printing Office, Washington, D. C. (1947).

Why are some schools more fortunate than others in developing boys and girls who become successful aspirants for the grand awards? Comparisons are frequently made between schools based on the number of honorable mentions, trip winners, and finalists which they have had. Are such comparisons valid? Is such competition educationally desirable? Do the award winners select professional scientific careers? These are some of the questions upon which attention has been focused.

Mr. Hugh Templeton, Supervisor of Science of the State of New York, has kept an informal record of Science Talent award winners from the years 1942 through 1950 in New York State Schools such as the Bronx School of Science, Forest Hills High School, Stuyvesant High School, and Brooklyn Technical High School have produced phenomenal records. These are large metropolitan high schools with the exception of the Forest Hills High School and are to some extent schools of a specialized nature. Students attending have been pre-selected to insure not only persons of ability but also persons with special interests and aptitude in science or engineering.

There are other schools of comparable size in the country with students of superior talent *which do not even approach the records of the forenamed schools. Why?* Let us examine each school to determine the particular method of approach in motivating scientists of the future.

THE FOREST HILLS HIGH SCHOOL, FOREST HILLS, NEW YORK

This large comprehensive high school of approximately 3,400 pupils is situated in a very favored socio-economic area of heterogeneous origin. Under the direction of an administration headed by Dr. Leo R. Ryan, principal, the dynamic Dr. Paul F. Brand-

wein, chairman of the Biological Sciences, and Mr. Brandon F. McSheehy, Chairman of Physical Sciences, a program for the promotion of science as a function of liberal education is offered.

Entering freshmen taking General Science are screened during the first few months according to (a) their high grades in science and (b) lower grades in science but the ability to work with their hands. Quoting Dr. Brandwein:[2]

"For our purpose is to give each student the environment to make the utmost use of his gifts and opportunities."

Those who show interest as well as ability are given the opportunity to work in the school laboratories during free periods, before, during, and after school. They are motivated in the sciences by helping to prepare teaching materials for Biology, Chemistry, and Physics, by assisting a specific teacher (sponsor), by maintaining aquaria and vivarium of forms, by participating in the science club program, and so forth.

Most students take Biology during their sophomore year. Towards the end of the first term in Biology, students are selected to enter a so-called Honor Class in Biology. The basis for selection is (a) high ability as measured by the I.Q., (b) reading score, and (c) achievement grades in the first three terms of science. Students whose programming makes it difficult to enter the Honor Class are given opportunity for similar work.

Students selected for this Honor group engage in some "original" research work. They learn laboratory techniques, learn to use and operate laboratory equipment of all types, participate in seminar club meetings, and prepare reports. They are learning through participation in the methods of science. Some of these pupils may drop out during the next two year period due to changes of interest or other factors. However, by the beginning of the senior year there is a nucleus of about ten "research" scientists. These are the individuals that engage in the annual science talent search.

Dr. Brandwein writes[3] that obviously a high I.Q. alone or high scholastic average does not guarantee success in science, but methods of selection indicate more than a modicum of success. An I.Q. 125–130 (Otis) is set as the lower limit. A good reading score, a remarkable capacity to learn and to work are all factors in the success of the Forest Hills High School.[4, 5]

THE BRONX SCHOOL OF SCIENCE, BRONX, NEW YORK

Under the inspiration and leadership of Dr. Morris Meister, principal, the Bronx School of Science was organized as a specialized high school around "a purpose that is both meaningful and attractive to the pupils."[6] The pupils are selected for this school not only on the basis of ability (Median I.Q. 135–140) but also on their interest and achievements in science. This does not mean that the education offered is "devoid of aesthetic and cultural content"[7] but the content from the fields of science is used as the function of a broad and cultural education.

"The greater homogeneity of the student body with reference to dominating interest, level of ability, and terminal aims opens up opportunities. . . ."[7]

This may be construed by individuals to justify the success of the Bronx School of Science in producing such amazing science talent results. However, it is more. It is the prevailing influence of a superior

[2] Brandwein, Paul F. Scientific Monthly, 64: 247–252, 1947.

[3] Op. cit.

[4] Brandwein, Paul F. Science Education, 36:1, February, 1952.

[5] Brandwein, Paul F. Science Education, 35: 251–253, December, 1951.

[6] Witty, Paul (Edited), "The Gifted Child." The American Association for Gifted Children. Pp. 210–234. D. C. Heath and Company, Boston, 1951.

[7] Ibid.

faculty trained in the methods and principles of science which permeates all the activities of the school.

As would be anticipated, the course offerings are both extensive and intensive. The many and varied extra curricular offerings, the use of the pupils in laboratory squads, experience in the techniques of the laboratory and in the use and handling of equipment, soon enable the young scientist to develop manipulative skills and interests beyond the usual classroom work.

Faculty members or sponsors are extremely generous with their time. It is not infrequent that a teacher and student will forego their lunch hour and will work on, plan, and discuss potential projects. It is from such common exchange of experiences that many research projects originate. Community resources and personnel are frequently used to assist in the developing of interest and in the working out of projects.

It is of interest to note that there is no concerted effort to produce "Science Talent" material. It is the coordinated cooperation of a favorable administration, superior faculty, and pupils of greater than average capacity that combine harmoniously to produce results. Dr. Meister emphasizes the undesirability of placing extreme emphasis on winning as a goal if it conflicts with the educational objectives of the child. Teachers have expressed the opinion that too much emphasis is being placed on the Westinghouse award for the sum total of the scholarship awards made.

STUYVESANT HIGH SCHOOL, NEW YORK CITY

This is another large metropolitan high school of 3,000 pupils where emphasis is placed on science as a function of education. It is a boys school where selection for admission is made by a battery of tests, achievement, and previous school recommendation. Students come from all five boroughs of New York. This is a school with a tradition, the tradition of scholarship and of accomplishment. Graduates take pride in saying, "I'm from Stuyvesant."

Specially selected students with better than average capacities (Median I.Q. 128) know that they will be working to capacity when they attend Stuyvesant High School. Mr. Fred Schoenberg, a most practical educator and principal, stated "we are dealing with superior boys, and we push these boys along." Many of their advanced electives are accepted at collegiate level for advance credit by pre-arrangement.

In the field of science, Stuyvesant High School offers such advanced electives as Micro-analysis, Electronics, Calculus, Surveying, Laboratory Techniques (in each of the sciences), Experimental Physics, and many more. The scope of the offerings is found in few other schools in this country.

Experimental Physics is a seminar and laboratory course including both project work and theoretical physics. As Dr. Efron has stated, "If you want to produce winners you have to go after them." Winning awards is not the educational function of this course but by its very nature it cannot help but produce such outcomes. Recognition and further stimulation is gained through participation in contests. These lads gain the respect of their fellow classmates through demonstration and project work not only at the school level, but in the city wide Science Congress and in national contests. A very homogeneous selection of boys of better than usual ability, a definite interest in science and all things scientific, and motivation by good teachers produce unusual results.

EVANSTON TOWNSHIP HIGH SCHOOL, EVANSTON, ILLINOIS

Examination of a school in the mid-west of comparable size to the specialized schools in the East indicates that science talent is not of sectional origin but universal in scope. Here under the leadership of the department chairman, W. E. Jones, and Mr. Murl B. Sailsbury, the chemistry teacher, two grand prize winners in five years have been produced.

Evanston High School is a large comprehensive high school similar to that of the Forest Hills High School in type of student body and socio-economic environment. The offerings in science are comparable. It does not offer the advanced courses that either the Bronx School of Science or the Stuyvesant High School are in a position to offer. Evanston High School has a method of its own in developing potential interest in science.

Mr. Sailsbury has said that top winners in science must be people of ability with a longtime interest in science or hobbies of a scientific nature. A select group of entering freshmen (I.Q. 130 or more) are observed when they first enter the school. Although scattered in various science classes (hetereogeneous grouping is used here) their science and mathematic teachers are alerted. They are encouraged in science and mathematics. They are invited to participate in laboratory work, to join the Freshman Science Club, and to consider science as a career. Each spring publicity is given to the Science Talent Search so that no potential contestant is missed.

Success is due to the early detection of pupils with interest and capacity in science and guidance in the methods of scientific research informally introduced. Project work is encouraged through all four years of school. Constant supervision many times unbeknown to the individual is the method used. Informal motivation by a most professional staff leads to unusual results.

In September or early October of the senior year, pupils are encouraged to submit a tentative draft of their project to Mr. Sailsbury. The draft is checked for accuracy of observation and originality by various members of the science department. Semantics are checked, and then with the aid of the English department a final draft is prepared.

No special time allowance is made to teachers acting as sponsors. They consult with the boys and girls during their free periods, before and after school. Frequently community assistance is sought. The school gives the prospective candidate all the help that will be of benefit to him, but the final report is essentially the work of the individual.

SUMMARY

1. Proper selection and motivation do encourage young men and women to follow professional careers in science. Among the 400 young men and women who have been named in the first ten Science Talent Searches, 302 have already chosen professional careers.[8]

2. Evidence has indicated that early identification is essential. Identification not only of persons with above average capacities, but also of persons with scientific leanings. A lifetime history of hobby interest is an indication of potential success in science and engineering.[9]

3. Selection of persons of great abilities and high capacities is desirable early in their careers so that they may have the experience of early laboratory exploration.[10] But merely a high intelligence quotient is not the determining factor. Better than average reading skills, a record of achievement, the capacity to communicate [11] are all indices in selection.

4. Cooperation and sympathetic understanding of many teachers are necessary. Teachers that have the ability to discover dormant capacities in pupils and know how to encourage their creative abilities can do much. Friendliness, a constructive attitude towards the individual, a knowledge of subject matter or where to obtain it, and a

[8] Davis, Watson. Sponsors Handbook, Science Clubs of America. Science Service, Washington, D. C. 1952 Edition. Pp. 35.

[9] Hollister, S. C., "The Shortage of Engineers." Engineering Manpower Convocation, Pittsburgh, Pennsylvania, September 28, 1951.

[10] General Education in a Free Society—Report of the Harvard Committee. (Cambridge, Massachusetts: Harvard University Press, 1945.) Pp. 175.

[11] Wiener, Norbert, "The Human Use of Human Beings" (Cybernetics and Society). Houghton Mifflin Company, Boston, 1950.

genuine respect for each individual are desirable characteristics of good teachers.[12] It is the teacher who is the dominant factor in the motivation and stimulation of the potential scientist.

5. Research has indicated the necessity to acquire familiarity with the ordinary tools of the laboratory. Manipulative skills, indoctrination into the methods of science, ability to observe and record are all factors in the development of the individual. The opportunity for creative expression should be available.

6. Opportunity of exploration through participation in extra curricular activity is desirable. Through a club program individual and group projects can be encouraged to give the individual a feeling of accomplishment and recognition.

[12] Witty, Paul, "Some Characteristics of the Effective Teacher." Educational Administration and Supervision, Vol. 36. (April, 1950), Pp. 193–208.

CONCLUSION

Discovering scientific talent and encouraging persons of ability to enter the scientific fields cannot be done at once. Highly trained personnel needed for the security and well being of this nation cannot be mass produced. The essence of training pupils for the world we live in is to bring apt pupils into sufficient and personal contact with the materials and methods of science as a function of their liberal education. It will be the teacher that will hold the key to the search for science talent.

BOOK REVIEWS

FERRIS, THEODORE PARKER. *The Story of Jesus.* New York (114 Fifth Avenue): Oxford University Press, 1953. 123 p. $2.30.

Significantly or not, the reviewer is writing this review in a certain hospital room number 343 whose walls are graced by a picture of Jesus watching his flock of sheep. In this unusual setting, the reviewer has read an unusually fine book. It is a challenging, thought provoking book, challenging for our times. This is especially true when one reads of hoodlumisn and the wide-spread delinquency that seems to be nation-wide all the way from Boston and New York City to Tulsa and San Francisco. Schools and education do not seem to be enough. Certainly they are only a partial solution to probably America's greatest problem and need.

This book is a retelling with some different interpretations of the familiar story of Jesus from His birth to the Resurrection.

The book is actually a series of sermons but does not really read that way. The author is candid, frank, and for the most part non-creedal. That is not to say that all persons will agree with his thinking and beliefs. Many will not do so, for many of his interpretations are not in agreement with the creeds and beliefs of many churches and millions of christians. The author does re-interpret much about the life of Jesus and in a way to make one re-think and possibly gain new attitudes and beliefs about the most important aspect of human living.

Altogether, this is one of the great books of our day in this area of human development. The author is one of America's greatest religious leaders. He is one of the fourteen distinguished ministers who since 1735 have occupied the pulpit of Trinity Protestant Episcopal Church in Boston. Notable among them was Phillips Brooks. Life Magazine in the April 6, 1953 issue presented Dr. Ferris as one of America's twelve greatest preachers. He is the author of *This Created World, Go Tell the People,* and *This Is the Day.*

ALVAREZ, WALTER C. *Danger Signals.* Chicago: Wilcox and Follett Company, 1953. 176 p. $3.00.

The subtitle of this book is *Warnings of Serious Diseases.* Intended for the layman, it is a most timely book, simply and understandingly written. Every family should really have a copy of this unusually fine book. The hope of the author is that the readers of this book may be saved from serious illness or premature death. Recognizing the danger signals that give warning of impending disease sometimes makes all the difference between life and death. The book will also save many people from needless anxiety. Knowing the symptoms that do not lead to seri-

ous illness is important to the well-being of every individual and to the peace of mind of his family.

The book is not intended to take the place of a physician nor as a guide for self-diagnosis or treatment. It does help the reader to decide whether or not a physician is needed and thus to an earlier diagnosis of conditions that may call for quick preventive treatment.

Danger signals of infancy, childhood, youth, middle, and later life are considered. Specific disease danger signals are considered in specific chapters.

Dr. Alvarez is a well-known writer of health articles for the layman. He has written many popular books and pamphlets for the layman as well as technical books and papers for the medical profession. He is Professor Emeritus of Medicine, Mayo Foundation, University of Minnesota.

LONG, EDWARD LEROY, JR. *Religious Beliefs of Scientists.* Philadelphia: The Westminster Press, 1952. 168 p. $3.00.

The religious beliefs of scientists more than any other professional groups, aside from religious leaders themselves, have appeared in the public press. Many books and articles have been written on the religious beliefs of scientists and the relations of science and religion. This book examines the religious beliefs of 20th Century American scientists who have written book length credos. It attempts to answer such questions as: What do scientists have to say about the meaning of life? On what grounds do they base their religious faith? Do scientists follow a pattern in dealing with the relationship of science to religion? The first part of the book starts from scientific knowledge to which it attempts to relate a religion; the second part starts with a religious conviction and seeks to fit scientific fact into its frame work.

The writings of such men as Einstein, the Compton brothers, Millikan, du Nuoy, Bush, Sikorsky, Mather, Pupin, Jordan, Osborn, are examined. Their religious beliefs vary widely. The author concludes that scientists as a group hold no religious views uniquely their own. "Only when competent science handles scientific matters and competent religion handles religious matters and a dialectical attempt to relate both to a total world view bridges the gulf between them, does a true reconciliation between science and religion result."

Altogether, this is a well-written, thoughtful analysis and synthesis of the religious viewpoints of a number of prominent American scientists. The book should prove to be of great interest to those interested in problems relating to science and religion.

KINSEY, ALFRED C., POMEROY, WARDELL B., MARTIN, CLYDE E.; AND GIBBARD, PAUL H. *Sexual Behavior in the Human Female.* Philadelphia: W. B. Saunders Company, 1953. 842 p. $8.00.

Sexual Behavior in the Human Female is undoubtedly the most widely quoted and discussed book of 1953 and in its area it will probably retain this distinction over a long period of time. To the reviewer, the book is much less sensational than newspaper and magazine reports would lead one to believe. On the other hand, it is much more scientific and statistical than one might assume from press notices and a great many readers seeking only the sensational may be quite disappointed. It definitely is a scientific and statistical study of the greatest significance. The validity of the findings and conclusions rest upon the degree to which the sampling is truly a random sampling. If the sampling is truly random, then the conclusions would seem to be justified.

The study is based on surveys made by the Institute for Sex Research at Indiana University. It is a companion volume to the earlier *Sexual Behavior in Human Male.*

The present study is based upon personal interviews with nearly 8,000 women, and studies in related fields. Much of the material was double-checked and every precaution used to assure accuracy. There are 155 figures or diagrams and 179 tables.

Many of the findings are contrary to popular beliefs and may seem startling to many individuals. Changes in legal procedures, social work, guidance, and attitudes, will probably result from this significant and exhaustive study.

YOUNG, ESTELLE. *Gone to Europe.* New York (120 East 39th Street): Richard R. Smith Publishing, Inc., 1952. 241 p. $3.00.

Gone to Europe is a charmingly written book that will delight all travelers and would-be travelers, and especially those who have gone or plan to go to Europe. Miss Young seems to be a born traveler who has fallen in love with the continent—its people, traditions, art, scenery, and so on.

The author writes intimately, interestingly, wittily of her voyage to Europe, illuminating it with interesting bits of conversation with her fellow-travelers. Miss Young takes the reader aboard the *Queen Elizabeth* in New York, through France to Paris, Monte Carlo and the Riviera, to Italy, Rome, Florence, the Swiss Alps, Switzerland, old Heidelberg and Germany, back to France, to England, and the Shakespeare country, and back home across the Atlantic. The account is replete with minute, interesting details of the places and people she saw.

Altogether this is a most interestingly written

travel book. But it is more than that. It also is a keen insight into present day Europe, what one may see when he goes there, and indirectly suggestive of how to get the most out of such a travel experience.

HORKHEIMER, MARY F. AND DIFFOR, JOHN W. *Educators Guide to Free Slidefilms.* Randolph, Wisconsin: Educators Progress Service, 1953. 185 p. $4.00.

This is the fifth annual edition of *Educator's Guide to Free Slidefilms.* This fifth edition lists 621 titles, 38 more than in the 1952 edition, and 177 new titles. Twelve sets of slides are listed. In 1946 only 82 free slidefilms were available from 40 sources. Under science are listed 100 titles of which 27 are new. In addition, many titles listed under transportation, safety, geography, health education, aeronautics, and agriculture are equally suitable for science classes. All new titles are starred (*). Thirty-seven of the filmstrips may be retained permanently by the borrower.

There is a useful discussion on how to use slidefilms and the slidefilm guide.

Slidefilms are listed alphabetically under subject headings with brief annotation, indicating whether silent or sound, and source. The films are also listed alphabetically by title and by subject. There is a source and availability index.

The growth in the number of slidefilms is indicative of the recognition of the teaching value of this type of visual education. Science teachers should have this *Educator's Guide to Free Slide Films* available as an instant source of an important adjunct to science teaching.

HORKHEIMER, MARY FOLEY AND DIFFOR, JOHN W. *Educators Guide to Free Films.* Randolph, Wisconsin: Educators Progress Service, 1953. 516 p. $6.00.

This is the thirteenth annual edition of *Educator's Guide to Free Films.* It seems that each new edition improves over the preceding one. The first edition had 102 pages and 671 titles. The 1953 has 242 more titles than the 1952 edition. The quality of films is definitely improving. This is due to a number of factors. Commercial and other producers better understand what is needed and there is better cooperation between producers and users. Certain groups are making an intensive study of films and more desirable standards have been set up. All subject-matter areas are covered. There is a total of 2,574 titles listed, of which 562 were not listed in the previous edition: New titles are starred (*).

In the sciences 46 titles are listed under biology, of which 22 are new; 114 titles are listed under chemistry, of which 16 are new; 195 titles are listed under general science, of which 55 are new; and 107 titles are listed under physics, of which 20 are new. In addition many titles listed under health education, conservation, consumer education, transportation, aeronautics, agriculture, and geography are just as appropriate in science.

Films are listed according to subject and are briefly annotated. There is a table of contents, subject index, cross index, source index, and availability index. A reprint of a circular by Dr. John Guy Fowlkes "The Significance of Films in Curriculum Improvement" is available upon request.

Many schools keep an up-to-date file of *Educators Guide to Free Films* available in the school office or library, or in the superintendent's office. Every school using films to any extent should profit greatly from having the *Guide* readily available. Many excellent films are free for only the asking and paying transportation charges one way.

TORGESON, THEODORE L. *Studying Children.* New York: The Dryden Press, 1950. 230 p.

Diagnostic and remedial procedures in teaching is the sub-title of *Studying Children* and adequately describes the contents of this text. Elementary classroom teachers will especially appreciate this well-written, easy-to-read, practical book. It is replete with anecdotal records, specific examples, and concrete suggestions, a feature that will appeal to teachers in the field. There are numerous charts and inventories that will be most useful. The wide usage of the book gives concrete evidence of its worthwhileness.

Chapter headings are: Child Study and Teaching; An Integrated Program; Why It Is Important to Know About Children; How to Identify Problem Behavior by Observation; How to Write and Interpret Anecdotal Records; The Interview As a Method of Studying Children; Studying the Child in the Home; The Use of Standard Tests in Child Study; The Selection and Evaluation of Tests; The Case Method in the Study of Children; and Prevention and Correction of Problem Origins.

MCKIE, DOUGLAS. *Antoine Lavoisier.* New York (20 East 70th Street): Henry Schuman, Inc. 1952. 440 p. $6.00.

This is probably the most complete and readable account in the English language of the man deservedly accorded the title "Father of Modern Chemistry." With his work, modern chemistry began. He stripped chemistry of its medieval heritage by showing the true nature of combustion and respiration, that the air consisted of two gases (one-fifth being oxygen, a name he coined). He solved the problem of the composition of water and drew up the first table of chemical elements.

All chemists and many scientists know the above facts about Lavoisier, but what most of them do not know is that Lavoisier was distinguished as economist and social reformer, that in agriculture he established the first experimental farm, that he devised detailed schemes for national education, and that he was a pioneer in planning social security.

Guillotined during the French Revolution,

Lavoisier died an untimely and tragic death at the age of fifty. All of his contributions to science and the public good were submerged by the fact that he belonged to the Ferme Generale, a commercial organization entrusted by the king with the collection of taxes, an organization which was the object of bitter and widespread hatred.

Altogether this is an unusually fine biography of interest to teachers of chemistry and to students of history and social reform as well.

Olmsted, J. M. D. and Olmsted, E. Harris. *Claude Bernard and the Experimental Method in Medicine*. New York (20 East 70th Street): Henry Schuman, Inc. 1952. 277 p. $4.00.

This is an interpretative biography of Claude Bernard now regarded as the founder of experimental method in physiology and whose experimental work was a factor in establishing medicine on a scientific basis. His research in physiology marks him as one of the greatest scientist of all times. A master dissectionist, his work on the activity of different glands and particularly the pancreas, animal glycogenesis, experimental production of diabetes, the existence of the vasomotor nerves and the theory of animal heat, and the influence of poisons, gives Bernard top ranking among all experimental physiologists. He was an assistant to another great experimenter Magendie and a contemporary of Pasteur with whom he was in constant contact.

The biography traces Bernard's development as a scientist and his early love of literature, art, and philosophy. As a young student neither his teachers nor his contemporaries thought of him as having any unusual ability or promise of greatness. Quite the contrary! His married life was quite unhappy, although his relations with his associates and friends were most cordial.

The actual writing of this very interesting biography was done by Mrs. Olmsted, wife of James M. D. She holds degrees from Oxford University in England and the University of Toronto. Dr. Olmsted, Professor of Physiology at the University of California since 1927, holds degrees from several institutions as well as being a Rhodes Scholar.

Lewinger, Elma Ehrlich. *Galileo: First Observer of Marvellous Things*. New York: Julian Messner, Inc. 1952. 180 p. $2.75.

Galileo has long been recognized as one of the world's greatest scientists. Not always so, as has been so often true in many other cases. Galileo was ridiculed, denied and degraded, persecuted and yet through it all, he maintained his integrity, even in shame.

Galileo was inventor, astronomer, mathematician. He discovered the law of falling bodies, constructed the sector, a compass still used in geometrical drawings, and built the first air bulb thermometer. He discovered the first four moons of Jupiter, the peculiar form of Saturn, the movable spots on the sun, and the phases of Mercury and Venus. He brought final proof to the Copernican Theory.

Yet this great seeker of scientific truth, tearing aside the veils of ignorance and superstition, had a most unhappy childhood and married life. A nagging mother, an indolent brother, parasite sisters, and an intolerant father made his early life anything but a happy one. His marriage was just as unfortunate. Only his sister Maria Celeste, a nun, gave him any love or happiness. His grasping son, Vincenzio, plagued him throughout life and his sister Livia called Sister Orchangel as a nun, paid little attention to him.

Deeply religious, he was accused of heresy. He was ordered to appear before the Inquisition at Rome at the age of seventy. He was nearly blind and in such poor health that he had to be carried to Rome to face trial. In a trial that was actually a farce, he was persecuted, shamed, scorned and found guilty. During the remainder of his life, he was in detention, five months in Rome, and later in his home in Florence.

He was not permitted to write or talk with friends or to carry on his scientific work. After eight years, a living death became a real death at the age of 78 years. Many years after his death Galileo was fully vindicated and accorded the honors to which he was entitled.

Altogether, this is an unusually fine biography written in a most interesting, readable literary style. Pupils and science teachers should thoroughly enjoy reading this story about one of our greatest scientists of all time. The book is highly recommended for the science book shelf and as supplementary reading material.

Wright, Helen. *Palomar: The World's Largest Telescope*. New York: The Macmillan Company, 1952. 188 p. $3.75.

Palomar is the story of the development of the Hale 200 foot telescope. It is a popular, official story of one of the greatest accomplishments of man. Countless newspapers and magazines, articles described the progress of the great Hale Telescope through the twenty years of its building. This book tells the entire fascinating story of its origin and development and its contribution to astronomical progress. Here Miss Wright traces the history of telescopes from Galileo to George Ellery Hale, founder of the greatest of all telescopes.

It is the story of a great dream, of many keen disappointments, heartaches and temporary failures, but ultimate success. First a dream, then a possibility, the disagreements over who should control it, the $6,500,000 (ultimate) grant by the Rockefeller Foundation, the expensive and disappointing experimentation on a quartz disc, the final casting of a successful mirror by the Corning Glass Company of Corning, New York, its tedious journey across the country to Palomar, the slow years of grinding it to perfection, its final mounting by the Westinghouse Electric

Manufacturing Company, and the dedication of the completed telescope on June 3, 1948, make a truly remarkable story.

In many ways, it is truly one of the great accomplishments of man. Long before but greatly enhanced by this latest accomplishment, the United States is easily the foremost nation in the world in the field of astronomy. We have come a long way from the time President John Quincy Adams dedicated a telescope in Cincinnati. And this telescope is truly American—from the dream that conceived it to its final completion.

The ability and ingenuity evidenced by the Corning Glass Works in casting so perfect and so large a piece of glass makes all mankind their debtor and surely gives them first place among all the glassmakers of all time, past or present. And it is a feat not likely to be duplicated for many a year to come. In a world torn by strife and dissension, with hundreds of billions spent for destructible purposes of war, man's supreme accomplishment in Palomar, of Corning Glass, will shine down through the centuries as one of man's great contributions to generations yet unborn.

As the story of such an accomplishment, this book will likely be, tracing carefully as it does the history of this Wonder of the World, a great book a hundred years, five hundred, or even thousand years from today. Congratulations to Miss Wright for writing such a memorable book, to the Macmillan Company, who published it, to George Ellery Hale who dreamed and planned, to the Rockefeller Foundation who financed it, to Corning Glass Works which cast it, and to Westinghouse Electric and to Manufacturing Company who mounted it. Americans should be truly proud of this Modern Wonder of the World!

ABETTI, GIORGIO. *The History of Astronomy.* New York (20 East 70th Street): Henry Schuman, Inc., Publishers, 1952. 338 p. $6.00.

The History of Astronomy has been translated from the Italian by Betty Burr Abetti. This is one of the Series in the Schuman *Life of Science Library.* It is surely an outstanding contribution to that excellent series. The general reader, the science teacher, the amateur astronomer and the professional worker will find this an unusually readable, interesting book. Certainly the literary style does not give much, if any hint, of being the translation of a foreign book.

The author gives a most interesting, not too long, early history of astronomy from its earliest beginnings among the Chaldeans, Greeks, Mayas, Jews, Phoenicians, Hindus, Chinese, and Romans. The major portion of the book deals with the period from Copernicus down to the present.

The author is most generous in his treatment of American astronomers and their contributions to the development and present status of astronomy.

The author is an authority on solar physics and author of numerous publications in astronomy. Presently he is Director of the Astrophical Observatory of Arceti in Florence, Italy. He has worked at the observatories of Naples, Rome, Berlin, Heidelberg, Yerkes, and Mt. Wilson.

The History of Astronomy is an excellent reference for physical science survey courses, courses in astronomy, and for elementary and secondary science teachers.

DAVIDSON, MARTIN (Editor). *Astronomy for Everyman.* New York: E. P. Dutton & Company, Inc., 1953. 494 p. $5.00.

Astronomy for Everyman is a popular book in astronomy that is comprehensive as to coverage but non-mathematical in treatment. A number of authors make contributions to this symposium. Nearly every phase of astronomy—instruments, methods, history, planets, sun, comets, planetoids, moon, meteors and meteorites, aurora and zodiacal light, and the stars and galactic systems are discussed. There is even a brief final chapter on interplanetary travel. Certain phases of astronomy are discussed in quite a bit of detail. Certain other phases are passed over but briefly. This latter includes theories of the age of the earth and universe, the origin of the solar system and the universe, and so on.

Laymen and teachers will find this a most readable account.

The editor, Dr. Davidson, is an English astronomer of note and formerly served two years as President of the British Astronomical Society. The other contributors are also recognized authorities in their respective fields.

DAVIDSON, MARTIN. *From Atoms to Stars.* New York: The Macmillan Company (Distributor). 1952. 280 p. $3.75.

This is a revised and enlarged edition of a popular book in astronomy first published in 1944. Many of the earlier parts have been revised and brought up to date. This applies especially to the material on the stellar universe.

It is definitely a book for the layman, devoid, for the most part, of technical and mathematical treatment. Modern developments and recent theories are discussed. The latter is especially true as regards the universe and as to the origin of the planetary system. Lyttleton's and Hoyle's theories of planetary origin are discussed along with some of the earlier theories.

Altogether, a reader will have a very good idea of present day knowledge and theories relating to the planets, the moon, the sun, comets, meteors, the stars, and the universe.

MARSHALL, ROY K. *Sun, Moon, and Planets.* New York: Henry Holt and Company, 1952. 129 p. $2.50.

Sun, Moon, and Planets is a popular description of the solar system. Laymen, teen-agers, general science teachers, and elementary science

teachers will find this a most readable interesting book. It would be an excellent addition to the school library. It is based on the author's long experience as lecturer and writer. While serving as director and lecturer at the Fels Planetarium in Philadelphia and at the Morehead Planetarium in Chapel Hill he was asked many questions about the solar system which he answers in this book. During the years at these planetariums and many lectures given previously at Adler Planetarium in Chicago and Hayden Planetarium in New York (over 5,000 demonstrations), many people asked him numerous questions. Dr. Marshall attempts to tell all the things about the solar system necessary for others than astronomers to know. Many readers have seen his television show on *The Nature of Things,* used also as the title of book previously reviewed in *Science Education.*

Aspects of the solar system described in this book include the universe we live in, the paths of the planets, exploring the planets, the earth's atmosphere, the moon's motion, eclipses of the sun and moon, a trip to the moon, satellites of other planets, measuring the universe, our star the sun, sunspots and their effects, the little planets, meteors and meteorites, comets, and the law of gravitation.

GAMOW, GEORGE. *The Birth and Death of the Sun.* New York (501 Madison Avenue): The New American Library, 1952. 219 p. $0.35.

This pocket-size Mentor Book was first published in 1940. This new edition has a preface which takes into account the latest developments in atomic physics. The reviewer has always considered the first edition of *The Birth and Death of the Sun* one of the most challenging and interesting books in the field of astronomy and atomic physics. Dr. Gamow truly ranks as one of America's greatest scientists and probably the foremost one in this particular area. Science teachers and laymen will find this a most readable book.

COUDERC, PAUL. *The Expansion of the Universe.* New York: The Macmillan Company, 1952. 231 p. $6.00.

The Expansion of the Universe is an English translation by J. B. Sidgwick. It is one of the most challenging and stimulating books in the field of astronomy that the reviewer has read in some time. It is a penetrating, thought provoking account of the fundamental structure of the universe. Professional astronomers and lay readers will both be interested in the interpretations made. Many parts of the book are not easy reading but the stated summarizations and conclusions can be readily understood by lay readers. It is an excellent book for all astronomers and for readers and writers of text books in the physical sciences. Writers of general science textbooks, secondary and college physical science textbooks must be aware of the conclusions stated or the information they present relating to the area of astronomy is likely to be completely out of date e.g. origin of the earth, size of the universe, age of the earth, and so on.

By and large, the author has synthesized in a most readable manner, the findings and thinking of scientists up to 1952 as to the structure of the universe.

Most astronomers agree that the Universe is rapidly expanding from an initial start of some four or five billion years ago. This age is much less than was commonly assumed even a decade ago. The age of the earth is approximately that of the Universe and radioactive rocks and lead formations seem to definitely date the earth as about three and half billion years old with an assumed error of less than ten percent.

The period since 1915 has changed the conception of the number of stars and their distribution almost beyond imagination—so rapid has been the advance in knowledge in these forty years. It was only in 1836 that a measurement was made of stellar distances and now the Palomar telescope enables man to reach out into space 500,000,000 light years!

Vestiges of a hyperdense state of the universe are still evident. Stars are relatively young. The author adduces evidence to account for the unbelievably rapid expansion of the universe and the red color of their receding galaxies. Evidences of the youth of the Universe include the radioactive elements, the Earth, individual stars, and stellar clusters. The existence of chemical elements of high atomic weight and probably cosmic rays indicate a former highly concentrated state of matter. The Universe itself was once a densely concentrated body that three to five billion years suddenly began its present expansion. Evidence seems to indicate the earth and the other planets were never a part of the sun. Evidence is at hand to show that there are many planetary systems like ours. Throughout the discussion Mr. Couderc is assimilating evidence to support his belief that the Universe is curved and probably closed and that it all started initially from a hyperdense state. Indeed this is a most challenging book for anyone interested in astronomy and in an up-to-date idea of the Universe.

ROBINSON, JOHN. *The Universe We Live In.* New York: Thomas Y. Crowell Company, 1952. 251 p. $4.50.

In many respects *The Universe We Live In* is about the finest book in popular astronomy that the reviewer has chanced across. It is truly a fascinating book to read. Some phases of astronomy are discussed as, or even more, interestingly than has been true of previously published books intended for the layman. This applies to such areas as *Time, Life and the Universe, The Great Universe of Modern Astronomy,* and so on.

The textual material is written in clear, readable style that will appeal to lay readers. It is as non-technical as it is possible to make a book as comprehensive as this one. There are forty photographs and sixty diagrams.

To the reviewer there are two areas which are inadequately treated but which could have made it the foremost book of its kind published in a long, long time. These two areas are theories regarding the origin of the solar system and the universe, and the information brought to light at Palomar.

Altogether, this is an unusually fine book. The reviewer recommends it as one of the best. It would be an excellent addition to the high school science library, for general science, physical science and elementary science teachers, and for any layman wanting to read an outstanding book in astronomy.

PAYNE-GAPOSCHKIN, CECELIA. *Stars in the Making*. Cambridge, Massachusetts: Harvard University Press, 1953. 160 P. $4.25.

Stars in the Making is one of the finest, most interesting books the reviewer has read in a long time. It points up the great advances that have occurred in astronomical discovery and thinking in the last decade or so. Probably only in the field of nuclear research has man made greater progress in this period. The changes in our concepts of the universe since the earlier concepts of Eddington and Jeans two or so decades ago can be described as truly drastic. Our ideas and conceptions of the structure and origin of the universe have been almost completely changed. So many of our former concepts, even of a decade ago, would seem to be obsolete. Not so long ago we were convinced that these ideas were in the main fundamental and would be changed only in minor details. Now many of these concepts have been wholly discarded. So one may wonder what will be the ultimate fate of some of the recently advanced concepts of the structure of the universe.

In a challengingly written, most readable account, the author recreates the drama of the birth and death of the stars—an exciting drama now being unfolded before our very eyes. The author summarizes the general conclusions she has reached in over 25 years of astronomical research.

The book opens with a magnificient parade of characters: bright red super-giants, dim white dwarfs, bursting supernovae, pulsating and eclipsing variable stars, well-known stars like Rigel, Betelguese and those far-off in galaxies whose distance challenges the imagination. Equally important to the drama are the great masses of interstellar dust and gas, and the basic component of the universe, the atoms. The author next describes the various grouping of the stars into twins, families, clusters, populations, nebulae, and galaxies. Stars in action—spinning, splitting, turning, spilling, exploding, and becoming rejuvenated—then play out their roles. The author tells how stars emerge from dust to gas, how they are nourished, how they expend their light and heat, and how they eventually degenerate. The evolution of the great galaxies from vague globular clusters to symmetric systems is traced.

An integral part of the book are 67 plates, illustrating the most striking cosmic phenomena that have ever been photographed.

Altogether this is one of the finest publications in astronomy appearing in many years. Science teachers and general readers will find this a most challenging and interesting book.

MENZEL, DONALD H. *Flying Saucers*. Cambridge, Massachusetts: Harvard University Press, 1953. 319 P. $4.75.

Flying saucers caught the public fancy during the last six years and have been "seen" by many people. But they are not modern as most people believe. Dr. Menzel shows that they go back as far as Biblical times (the wheels of the prophet Ezekiel) and have had infrequent appearances ever since. This book presents a popular, interesting, humorous, entertaining mixture of history, science, yarns, and special investigations of the author. Since 1947 there have been some 1157 "unexplained" sightings. The recent furor has had its counterpart on numerous occasions such as 699, 1462, 1600, 1855, 1882, 1897, and so on. Recently some affirmed that we had actually been invaded by Men from Mars and Men from Venus. Many people who "seen" them were convinced that the "flying saucers" were real. In a sense they were correct. They were probably as real as a rainbow, a mirage, or a sundog. Many of them involve nothing more mysterious than meteors, planets, stars, lenticular clouds, search lights, birds, high-flying aircraft, kites, the aurora, St. Elmo's fire, balloons, and hoaxes. Halos, glories, coronas, sundogs, rings, mock suns or moons, reflection and refraction effects, "air lenses," ice crystals account for many. Strangely enough no actual saucer either in whole or in fragments has even been found. This is one of the best proofs that they have not been material substances.

The author mentions many other things, too, such as atom bombs, rocket ships, relativity, rain making, and ball lightning.

Dr. Menzel is a noted authority in astrophysics, radar, and solar research.

Undoubtedly this popular discussion on flying saucers is the most authoritative and comprehensive treatise thus far in an area that has been so sensationally played up in the public press in recent years. Science teachers and students as well as laymen will find this a most readable account on "flying saucers" and what mass psychology can do even to well educated individuals.

BRONOWSKI, J. *The Common Sense of Science*. Cambridge, Massachusetts: Harvard University Press, 1953. 154 P. $2.00.

The author believes that the layman's key to science is its unity with the arts. It is not a book about a particular science but about science in general, how it appears in the life of each of us today and how its methods can be used in all we do.

According to Dr. Bronowski "no man of science, no man of thought has ever equalled the reputation of Isaac Newton." His era marking

also the beginning of the Royal Society was a period of the greatest progress in science and the arts. This was followed by a period of decline lasting until about 1880. A major thesis of the author is that nations in their great ages have not been great in art *or* science, but in art *and* science.

So-called "laws" in science, "cause and effect", "chance", "probability", are discussed at some length. "Science is not only rational; it is also empirical. Science is experiment, that is orderly and reasoned activity. The essence of experiment and of all science is, that it is active. It does not watch the world, it tackles it."

The author agrees that science and society are out of step and the only solution is for mankind to learn to understand both. In the final analysis science must itself bridge the gap to bring unity into our culture. In a strict sense there are no exact sciences as we view science of the twentieth century. "There is science and there is common sense; and both must learn to assimilate into their methods and basic ideas the underlying uncertainities of all knowledge."

The Common Sense of Science is a non-technical book that is intended to give an integrated view of science as it is in the world of today. Science teachers and educated laymen as well as pure scientists will find the book most stimulating.

Wyler, Rose and Ames, Gerald. *Life on the Earth.* New York (20 East 70th Street): Henry Schuman, Inc. 1953. 143 P. $2.50.

This title is one of the Schuman *Man and His World* series, under the general editorship of Dr. Nathan S. Washton. The first named author is a well-known writer and consultant in elementary science. Mr. Ames is a scientific writer and illustrator. The book is intended for the junior high-senior high school level. This volume should be of interest to general science and biology students and to teachers as a source or reference book. There are black and white illustrations by Gerald Ames.

The authors trace, in non-technical language, life from its simple beginnings to the development of the primates and man. They explain how life began, how plants and animals react to the environment, and how they utilize food. They explain the working of protoplasm and how plants and animals obtain energy. The development of new species from old, the story told by fossils, and the conditions on earth favorable to life are all explained simply and briefly.

Webster's New World Dictionary of the American Language. New York (119 West 57th Street): The World Publishing Company, 1953. 1760 P. $5.00 plain edges; $6.00 thumb-indexed.

This is a college dictionary, one of the finest dictionaries of the American language. There are over 140,000 words and 1,200 illustrations covering both terms in general vocabulary and specialized fields—all important idiomatic expressions, the colloquialisms and slang, and the most characteristic of American English. Definitions are in mid-twentieth-century style and from an American viewpoint. There are listings of places and notable persons, foreign expressions, abbreviations, etc., all listed alphabetically in the main body of the book. This later feature makes for a much more useable book. It defines such terms as cybernetics, flying saucer, be-bop, wetback, napalm, falsies, and so on.

Even the first part of the book for many teachers, especially the English teacher, is worth the total price of the book. It is literally jammed with valuable information telling how to use the dictionary: the entry words, pronunciation, inflected forms, etymology, the definitions, and the synonyms; and the English Language: modern American English (pronunciation, chief grammatical features, American English and British English), the descent, relationships, and history of the English language, and the development of the English Dictionary; and abbreviations and symbols used in the dictionary.

Science teachers will especially appreciate the *recency* and *accuracy* of definition of new science terms. They will also appreciate its compactness, appearance, and general complete coverage.

This is truly an outstanding dictionary that secondary and college students, teachers, and laymen will especially appreciate having as a personal copy. It is equally good for school libraries.

Meyer, Jerome S. *The Book of Amazing Facts.* New York (119 West 57th Street): The World Publishing Company, 1950. 190 P. $2.00.

Many amazing facts are listed in this book of unusual information. The facts are all authentic and were carefully checked and verified by the author. They deal with all sorts of things and are classified under the general headings of science, nature, people, buildings, transportation, literature, sports, and miscellaneous. They include such items as the fastest four-legged animal, the largest and most powerful animal, the laziest animal, the most dangerous animal, the fastest bird, the largest flying bird, the smallest book, the longest sentence, the highest priced book; the largest bank, American flag, bell, bridge, church, check, library, thing in existence; the oldest living thing, the smallest church, the longest railroad track, the oldest living new father, the longest street, the longest name, the most valuable stamp, and so on.

Altogether this is a most interesting book to read and have as a source of information on the unusual.

Meyer, Jerome S. *Fun With Mathematics.* New York (119 West 57th Street): The World Publishing Company, 1952. 176 P. $2.75.

Fun With Mathematics is aptly named. It is a rich source of fun and information for all

persons enjoying the magic of numbers. Here are all kinds of mathematical slights of hand such as magic squares that work right side up, upside down, and in the mirror; mathematical puzzles, mathematical fallacies and curiosities, how the Romans multiplied and divided, baffling tricks, and so on.

A great deal of the material in this book is new. Examples of this are the methods of making a good slide rule from an ordinary ruler and a chart which instantly solves problems of the right triangle without the necessity of knowing any trigonometry.

This is a highly recommended book for teachers of mathematics, for all students interested in mathematical puzzles and tricks, and for the secondary school book shelf.

WALSH, CHAD. *Campus Gods on Trial.* New York: The Macmillan Company, 1953. 138 P. $2.50.

College students like most of the rest of us have a number of Gods, including the Christian God. In the competition among these various Gods, the Christian God does not always win out.

Chad Walsh, the author of *Campus Gods on Trial* is a professor of English at Beloit College, Beloit, Wisconsin. He says that our college campuses instead of being "godless campuses" are not actually that at all but are really overpopulated with gods. These gods of the classroom he calls Progress, Relativism, Scientism, and Humanitarianism. They compete with the God of the Bible. Outside of the campus, noncollege people seem to the reviewer to have as many and as powerful gods, if one is to judge them by either their words or their performances, or both.

Admittedly college students do face what is often to them difficult and complex problems regarding religion and God. Often those outside the campus add to the difficulties and complexities of these problems.

Professor Walsh discusses various aspects of the religious struggles of college students. He tries to answer questions raised by students frankly, honestly, and practically. On the whole, he seems to be optimistic regarding religion on college campuses. There is an excellent selection of books for further reading. These are classified under a number of headings.

Altogether this is an unusually fine book. It is likely to be a most popular book for many years to come among many college students and adult leaders in Christian work.

LYND, ALBERT. *Quackery in the Public Schools.* Boston (34 Beacon Street): Atlantic-Little Brown and Company, 1953. 282 P. $3.50.

With wide distribution, this book is likely to be one of the most controversial, widely quoted, fighting, severely denounced books in education in many a year. There will be much groaning and gnashing of teeth. A number of "vested rights" in education are severely trampled upon.

Mr. Lynd, a business man and member of the Sharon, Massachusetts, School Committee, was formerly a college teacher of history. Some of the major theses of Mr. Lynd are:

Education is a huge enterprise which has been taken over by the "Educationist", a group of super-professionals who, without visible public sanction, are remolding our schools according to theories of education which are largely unknown to the parents and the public. Mr. Lynd opposes their theories but it is for the Educationists themselves and their "copper-riveted beaucracy" that he reserves his strongest indictment. He contends—

1. That the fearful prose of Educationist publications explains why we are fast becoming a nation of illiterates
2. That each succeeding generation is graduating with a weaker sense of our cultural heritage
3. That the older curriculum needed change but "the reform has devoured that which was to be reformed"
4. That Education with a capital "E" has supplanted genuine education in the training of teachers
5. That only by raising standards and by sharply raising salaries can the teaching profession entice better minds.

Severely attacked are professional Educationists in Schools of Education and Teachers College, Progressive Education, most educational research, the scramble for semester-hours credits and degrees, "box-office" courses, the core curriculum, and the Kilpatrick philsopohy. The textual material is enriched with numerous quotations and citations.

In passing, it might be pointed out that Professor Corey in his recent *Action Research to Improve School Practices* was equally critical of research in the field of education.

Undoubtedly much of the criticism by Mr. Lynd is justified. In fact, in so many instances does he have the greater evidence on his side, that the sharply stated indictments definitely puts his antagonists on the defensive. One group coming in for less criticism than might be expected or deserved is the school administrator. They are actually a major part of the Educationists at whom Lynd aims his keenest darts. It is rather strange they are let off so lightly when so many others are so severely criticised.

Regardless of what one may personally think of the alleged quackeries, the book will serve a most timely and useful purpose in making Educationists, school teachers, and the public seriously scrutinize the purposes and shortcomings of American education.

BROOKS, JEROME E. *The Mighty Leaf: Tobacco Through the Centuries.* Boston: Little, Brown and Company, 1953. 361 P. $5.00.

Tobacco is truly "the mighty leaf." It is unique among the plants. Neither a basis of food or drink or wearing apparel, nevertheless, it occupies almost a place of greater importance than any single plant utilized for either of the three above purposes. Possibly wheat, corn, rice, and cotton may be of greater importance, but there are plenty of people including many Americans who would prefer going without one of these four plants rather than being deprived of tobacco. In a very real sense, tobacco serves no truly essential phase of our lives. Yet, possibly many people would sooner rise up in revolt over deprivation of tobacco than they would from deprivation of one of the four above mentioned plants, or even education! Today Americans spend more for tobacco than they do for public education. But this was not always so. Man did not know about tobacco before the discovery of America in 1492, for tobacco is one of America's noted contributions to civilization. Man's use of tobacco grew slowly, and no doubt now in 1954 is at its peak.

The author traces the growth and use of tobacco from the time Columbus was introduced to it by the Indians down to the present time. It traces the changes in smoking fashions including the era of tobacco chewers and snuff users down to the present cigarette age. Details of modern culture and manufacture processes are described, the development of advertising methods associated with tobacco promotion, analyzes what tobacco smoke is, why people indulge in the smoking habit, effects of smoking, the reasons why psychological tests of smokers fail, and so on. It is closely interwoven with the economic, social, and political history of America and the world. This book is a most complete record of the history, dramatically and humorously told by noted authority in the field. He is author of a larger four-volume work on tobacco.

A few of the many interesting things pointed out by the author:

In England, they paid the equivalent of $125 for a pound of best Spanish, a few pounds bought an African Negro slave, colonial wives were purchased for 120 pounds of tobacco, and ministers were paid salaries in pounds of tobacco. Ministers charged 200 pounds of tobacco for marriage service and 400 to conduct a funeral. Tobacco long served for bartering purposes in lieu of very scarce monetary exchange.

England had hired professors of whiffing to teach people to smoke, spanked school boys who forgot to take their "medicinal" pipe, and Englishman risked jail to plant tobacco.

In Russia and the East, smokers faced torture or death for a bowlful of tobacco.

For three centuries tobacco was a fixed part of European medical service practice and was prescribed for a multitude of ailments and diseases, whether corns or halitosis, cancer, or tetanus. It was used as an ungyent, an emetic, a cathartic, a remedy for coughs, colds, headaches, gangrene, and paralysis.

It was once popularly believed that women smokers would grow mustaches, become sterile, and eventually collapse.

The wives of two American presidents were reputed to be pipe-smokers. Queen Caroline of England chewed tobacco as a dentifrice (as did many other people). Catherine de Medici was an inveterate user of snuff.

During the Great Plague of 1664–1666 school children were forced to take a daily "medicinal" pipe of tobacco.

Until 1880 it was illegal to smoke in the streets of Boston. Sneezing by the use of snuff was once a very popular pastime.

Tobacco juice-squirting contests were held in North Carolina in the forties—even down as late as 1946 or maybe even the present! (The U. S. used nearly 100,000,000 pounds of chewing tobacco in 1947 and 8,000,000,000 cigars in 1920 when cigar smoking reached its peak.)

Chewing tobacco reached its peak about the time of the Civil War or shortly before but so common was the habit that foreign visitors suggested that the eagle be replaced by the spittoon as the American national emblem!

FEINBERG, J. G. *The Atom Story.* New York (15 East 40th Street): Philosophical Library, 1953. 243 P. $4.75.

The subtitle of this book is "Being the Story of the Atom and the Human Race." While asserting to be a book for the layman, it would be a little technical in parts for most laymen. Science teachers especially high school chemistry and physics teachers should find no difficulty at all in reading the book. Elementary science teachers will be able to read most of it with not too much difficulty. After noting these exceptions, it may be said that this book is really an outstanding book in its field. In general, the treatment is historical and a number of new incidents are brought out, some old in a new light, but others are entirely new.

The history of the atom began in Greece five centuries before the dawn of Christianity. From here step by step, the author unfolds the story of man's thinking about and experimenting with the atom.

An important addenda to the book is the inclusion of the U. S. Government's official recommendations for "Survival Under Atomic Attack." The latter, full of vital information gives an authoritative, non-sensationalized, and in many ways reassuring appraisal of one's chances of remaining alive in case of an atomic bomb attack.

STREET, PHILIP. *Between the Tides.* New York (15 East 40th Street): Philosophical Library, 1953. 175 P. $4.75.

Between the Tides tells about the life found along shorelines between the tides. And an in-

teresting, fascinating life it is, as many people will affirm either from their own personal experiences or through observing others. It is a numerous, varied life, too—both plant and animal. Here one finds seaweeds or algae of many colors—snails, barnacles, crabs, sea-anemones and their relatives, mussels and other bivalves, many kinds of worms, starfish, sea-urchin, shrimp, sponge, sea-squirts, boring animals, fish of many kinds, octopus, and so on.

The author is an English authority on marine life. Numerous plates supplement the textual material. The treatment is non-technical and may be readily read by biology students and junior high school students. Elementary science teachers and biology teachers will find it a valuable resource book.

RICHARDS, O. W. *The Social Insects.* New York (15 East 40th Street): Philosophical Library. 1953. 219 P. $4.75.

The Social Insects are those that live together in communities: bees, wasps, ants, and termites. Their activities have long fascinated many laymen as well as scientists. Men have long wondered how it is that creatures with brains so much smaller than our own are able to co-operate and to do so with marked success. Some of them are of great economic value to man.

Dr. Richards is a leading English authority on social insects and in this book, he presents the results of recent research and observations, including his own, in a lucid and authoritative account. Facts often seem more strange and fascinating than fantasy as Richards writes so vividly about our best known insects. The author specifically points out the contrast between insect and human societies. Numerous photographs accompany the textual material.

Laymen, high school biology students, elementary science teachers, and biology teachers will find this a most interesting book to read and use as a resource book.

BARTER, E. G. *Relativity and Reality.* New York (15 East 40th Street): Philosophical Library, 1953. 131 P. $4.75.

The aim of the author in this study of modern views on Relativity is to eliminate such difficulties as a fourth dimension, a curved space, a limited but unbounded universe. The author makes no criticism of Einstein's mathematical Theory of Relativity, but he examines from a new point of view the foundations on which it rests and the concepts it employs. The reinterpretation which he offers clears up certain "paradoxes" while leaving the scientific value of Einstein's work unaffected. This is an attempt to bring the Theory of Relativity into complete accordance with our common sense ideas of space and time, and thus, so to speak, "straighten out" the world again. The book is free as possible from technical language and mathematics.

Two quotes from *Relativity and Reality*:

The distinction between reality and unreality is thus essentially a matter of experience, the difference between what is forced on us by the mind as an external existence independent of ourselves, which we perceive, and what we know the mind is creating or imagining.

Truth, then, is consistency and does not necessarily involve reality. Reasoning, mathematical or any other, can be true and yet have no connection with reality.

FOTHERGILL, PHILIP G. *Historical Aspects of Organic Evolution.* New York (15 East 40th Street): Philosophical Library, 1953. 427 P. $6.00.

An apt subtitle for this book would be the "evolution of evolution." It is a historical study of the development of the idea of evolution going back to the very beginnings. The author states that:

"The conception of organic evolution had its basis in a philosophical notion of change involved in the idea of 'coming-to-be' and 'passing-away'."

The first part of the book consists of a historical survey of evolutionary theories, from the first hints by Aristotle and the early physicists, through Linnaeus and Buffon to Lamarck, Darwin, and their extensions in neo-Darwinism and neo-Lamarckism. Naturally much space is devoted to Darwin's expressed views and the approval and criticism of his contemporaries. The relation of the works and ideas of DeVries, the gene chromosome and mutation theories, the investigations of Morgan, McDougall, Muller, Willis, Goldschmidt, Pearl on the concept of evolution are considered in some detail.

The author is very careful to point out that evolutionary ideas have not yet reached finality. He also states that there is no reason why a sound concept of evolution should conflict with the Christian revelation.

Professional biologists and general readers will find this an excellent discussion of the development through the ages of man's concept of evolution. The treatise is well documented. The author is Lecturer in Botany, King's College, University of Durham, Newcastle upon Tyne.

RODICK, BURLEIGH CUSHING. *American Constitutional Custom: A Forgotten Factor in the Founding.* New York (15 East 40th Street): Philosophical Library, 1953. 244 P. $4.75.

This is a study of early American Constitutionalism. The author traces its growth from the colonial founders to the election of Jefferson. How did our Constitution and form of government grow and develop as it did? It is based upon habit, custom, and tradition, their growth and evolution. English liberalism rather than French liberalism and English tradition rather than French tradition predominated.

This book is an unusually fine book for the thoughtful American who has an interest in the

constitutional beginnings of the greatest democracy on earth. It is for the lay reader and is devoid of baffling legalisms. There are 90 pages of notes and bibliography used by the writer in gathering material for the main treatise. These notes are important documentary sources and often contain interesting quotations.

Goldschmidt, Richard B. *Understanding Heredity.* New York: John Wiley & Sons, Inc. 1952. 228 P. $3.75.

Understanding Heredity is a popular introduction to genetics. Most persons in varying degrees, are interested in heredity. Many persons have a practical interest in heredity, some a scientific interest, and a majority a cultural interest. This is a book especially for the latter group. The science of genetics has now pinned down the facts that give us a clear solution to what once was the fascinating puzzle of heredity.

The author first establishes *what is* and *what is not* inherited. Then he shows how sex cells control all hereditary traits. On this basis the famous laws of heredity are derived. Then follows an explanation of chromosomes and their behavior, mutation, hereditary blood groups, radiation genetics, chromosomal rearrangements, sex-determination, genetics, and evolution.

Dr. Goldschmidt, Professor Emeritus of Zoology at the University of California at Berkeley is one of the foremost authorities in the world on genetics. He is the author of a number of textbooks and popular books in the field of heredity. No previous knowledge is assumed, yet this is equally an excellent book for those who have some background in genetics. It is a highly recommended book for the high school science library, for biology students, elementary science, general science and biology teachers, and laymen who have a reading interest in the study of heredity.

Rosin, Jacob and Eastman, Max *The Road to Abundance.* New York: McGraw-Hill Book Company, 1953. 166 P. $3.50.

The Road to Abundance is the most optimistic book on conservation this reviewer has ever read. In fact, the rosy picture painted is almost beyond our dreams and one wonders can it even partially be a reality. In one sense, if accepted too literally by Americans the book could be positively harmful, should the authors be partially or even completely wrong. Also in another sense many or even most Americans *act* as if they did accept the author's assumptions when as a matter of fact in so acting they are not doing so because of any of the author's basic assumptions. A prominent authority is quoted as saying that while he did not agree with all of the author's prognostications, yet the arguments of the book are based on sound and thorough knowledge of physics and chemistry and the conclusions are in keeping within the laws of nature. But can man en masse rise to the occasion and meet the challenge which is possible?

Just what do the authors—one a prominent research chemist (Dr. Rosin) and the other an eminent writer (Mr. Eastman) say to the prophets of doom? They say that not only is there no need for starvation and for lack of material resources but the future can supply all of the food and material resources man can use—regardless of the probable tremendous increases in the human population. This is possible if man will put his trust and invest his money in chemical research and manufacture. The possibility of attaining a truly chemistic society is now at hand. Even now in many areas we know enough to solve many of our important problems if we made a serious effort. Solutions to other vital problems will be at hand when necessary if we really begin to make the effort now.

Two major problems face man—both solvable in the opinion of the authors. One is freedom from dependence upon plants and the second freedom from the mine (material resources). The last part of this extremely challenging book discusses chemistry and civilization.

Lilienthal, David E. TVA: Democracy on the March. New York: Harper and Brothers, 1953. 294 P. $3.50.

This is the Twentieth Anniversary Edition. It has been twenty years since TVA was placed in operation in 1933. In 1944 the first edition of this book describing the development and advantages of TVA was published. This 1953 edition has been revised in places, a new note of introduction written by the author and new material on other TVA's in other lands added to the appendix. The comprehensive bibliography has been revised. Approximately 200,000 copies of the first volume have been sold in American editions alone and it has been translated into eighteen languages.

TVA or the idea of TVA has been long a controversial issue and still is, notwithstanding Lilienthal's new introductory note. Labeled by its opponents as a trend toward and an experiment in socialism, the author and friends of TVA say exactly the opposite is true. Quoting from the author's new introductory note "TVA is an effective effort to decentralize the functioning of the federal government to reverse the trend toward centralization of power in Washington, to delegate, dilute, and withdraw federal power out of Washington and back into the regions and states and localities, insofar as the development of natural resources is concerned."

Regardless of the pros and cons involved, both sides would admit that TVA has been a success in so far as the people living in the valley are concerned. The betterment of their lot in life has in turn benefited the lives of the rest of the citizens of the country. Arguments on the other side need not be discussed here, but they are many. In fact so widespread has been the opposition that the socialistic Truman administration, usually on the lookout for a way to spend money, never devised any Ohio, Wabash,

Missouri, Snake or other TVA's. Yet many today, on both sides of the controversy, wonder why more such TVA's have not been initiated in the U. S. rather than laying our vast expenditures in Europe and other places in the world where friendship inculcated toward the U. S. seems to be almost in reverse ratio to the vast sums expended. Had such money been spent on local TVA's almost every possible local TVA would have been a possibility at a great saving of American taxpayer's money, and we would probably had a lot more friends in the world than we now have. Belatedly we seem to be learning money did not nor never has, purchased real friendship.

BILLINGS, HENRY. *All Down the Valley.* New York (18 East 48th Street): The Viking Press, 1952. 208 P. $3.50.

All Down the Valley is the story of the TVA and how it has transformed the geography of a great region and the lives of the people who live in the great valley. It is a book about water and people, combining history, geography, economics, sociology, and engineering. The region involved is an area of 40,000 square miles, spread among seven states. It is a story of water, forest, land, and human conservation. Once a rich land, the white men of the valley had heedlessly, persistently, albeit unintentionally, wasted the once abundant and rich resources of the area.

The author first briefly reviews the historical aspects of the Valley—first the Indians, then early white settlers, the Civil War period, the post war period down to 1933. The setting-up of the TVA authority, its operation, the construction of the various dams, the post TVA development of the region, and the rehabilitation of the people of the entire region are vividly described by the author. Altogether, the author enthusiastically describes it as one of the greatest engineering, conservation, and rehabilitation accomplishments in American history. So rosy is the picture described by Mr. Billings, one must regret that similar government projects have not been attempted in dozens of other American communities.

COMMITTEE ON COLORIMETRY OF THE OPTICAL SOCIETY OF AMERICA. *The Science of Color.* New York: Thomas Y. Crowell Company, 1953. 385 P. $7.00.

This is the definitive account of the science of color which the Committee on Colorimetry of the Optical Society of America has been preparing since 1932. Altogether the book is the most extensive, authoritative work on color that has ever been written.

It begins with the popular story of the use of color by prehistoric man and the use of color by the people of Babylon, Egypt, Crete, Greece, and Rome. Succeeding chapters carry the reader imperceptibly into increasingly technical accounts of the philosophy of color, the anatomy and physiology of color, the psychology of color, the physical principles that underlie the occurrence of color, and finally psychophysics that has made possible the measurement and control of color.

There are 25 full-color plates, 102 graphs and diagrams, and 40 numerical tables. There is an extensive glossary-index and over 700 titles in the extensive bibliography.

Many people will very much appreciate this most authoritative and comprehensive treatise on the science of color—physicists, industrialists, artists, science teachers, and all other persons interested in various aspects of color and its place in modern life.

MOYER, JOHN W. *Practical Taxidermy.* New York: The Ronald Press Company, 1953. 126 P. $3.00.

This working guide on taxidermy shows in detail how to prepare mounts of birds, mammals, fish that are true to life. It gives the proper procedure for field collection, lists the essential tools, and shows how to mix the various formulas and solutions. Through step-by-step, easy-to-follow instructions, the tested, present-day techniques for skinning specimens, treating and curing skins, mounting realistic displays, and finishing them in a life-like manner, are presented. There is a chapter on tanning methods.

The author is well-known taxidermist and authority in the field. He has served as taxidermist with the Aard-Vark Studio, as Director of the Chicago School of Taxidermy, and as Staff Taxidermist of the Field Museum of Natural History in Chicago.

GAUL, ALBRO. *The Wonderful World of Insects.* New York: Rinehart and Company, 1953. 290 P. $4.00.

Possibly most people consider insects harmful but the author emphasizes the beneficial aspects of insects in this delightful book intended for the layman. The author writes with a most readable literary style and presents many interesting facets of insect life. This is not only an enjoyable book for general reading but is a valuable reference for elementary science, general science, and biology teachers. It is highly recommended for the science book shelf.

There are far more species of insects than all other kinds of living things combined. It is estimated there are 750,000 species of insects of which 95 per cent are positively beneficial. One square yard of the earth can support 10,000 or more insects. Within 8 weeks the progeny of a single wasp could kill billions of caterpillars. Man has adopted all sorts of insect devices to his own use. A number of excellent photographs by the author is included in the descriptive material.

The author is a noted entomologist, working for many years with the U. S. Department of Agriculture and the New York City Department

of City Parks. He is a former president of the New York Entomological Society.

The book has an unusual and quite attractive format. It is the first volume composed with the revolutionary Higounet-Moygroud photographic type-composing machine. Absolutely no type, in the conventional sense, was used in the preparation of the book. This book could well represent the beginning of a new era from the usual linotype and monotype made by keyboard operation.

RAKESTRAW, NORRIS W. *Journal of Chemical Education, 25-year Cumulative Index. Volumes 1 to 25. 1924–1949.* Easton, Pennsylvania: Journal of Chemical Education, 1952. 106 P.

This *25-Year Cumulative Index of the Journal of Chemical Education* is a most useful reference. Research workers, chemistry teachers, and chemists will find it most valuable as a quick source of information for many articles written on chemistry and chemical education during the quarter of a century 1924–1949. Starting out somewhat hesitatingly and as a relatively small volume, the Journal of Chemical Education has reached a state of stability and world renown possibly exceeded by only two other science publications in America.

The volume is indexed both by author and by article title. It should serve as a great timesaver for chemical education and science education research workers.

SPALDING, WILLARD B. AND MONTAGUE, JOHN R. *Alcohol and Human Affairs.* Yonkers, New York: World Book Company. 248 P. $1.72.

Much statistical information is presented in this treatise on alcohol. Practically every aspect is covered—early use of alcohol, the manufacture of alcohol, alcohol as a major industry, the effect of alcohol on the body, the effect of alcohol on society, controlling the consumption of alcohol by legal means, the relation of alcohol to religion, how alcoholics may be helped, some things that may be done about the problems of alcohol, and the effects of using tobacco and narcotics.

Because of the wealth of statistical material involved, the book is an excellent resource for adults and teachers concerned with the problems of teaching the effects of alcohol. This latter statement is true only if one recognizes the definite bias on the conclusions drawn. In spite of much negative evidence, the book is slanted toward the idea that alcoholic consumption is not too serious a problem and that its importance in automobile accidents (fatal and otherwise), broken up homes, poverty, divorce, dependent children, crime and so on is a less important factor than is commonly assumed. Exceptions could be taken to many of the statements and conclusions made. Judiciously used, teachers will find the book a source of much important statistical data. The authors seem to be definitely convinced that alcohol is an evil that has to be put up with and handled in as effective a manner as possible. Moderation in controls, use, and attitude may be the most wise solution, they seem to believe.

Dr. Spalding is former Dean of the School of Education at the University of Illinois and Dr. Montague is associated with the Medical School of the University of Oregon.

SEARS, VICTOR H. *New Teeth for Old.* St. Louis: The C. V. Mosby Company, 1952, 110 P.

Most or even all people have dental problems—if they live long enough. And a few do not have to live very long! A considerable number of teenagers have to have dentures and very few escape going to the dentist. If George Washington could manage to live with his dentures, surely no one today should have any complaints!

Much progress has been made since Washington's day. This is not to say that there is no need for greater perfection—definitely there is, and every one needing dentures presents a new problem. There are more than 20,000,000 denture wearers in the United States—about one and one-half million new sets of dentures are made each year.

The first two chapters discuss matters of importance to those persons having natural teeth. The latter chapters discuss: right and wrong foods, infectious types of dentures, making, fitting, and servicing dentures, and how to enjoy dentures.

This is an excellent book especially for those wearing dentures and also for prospective wearers.

NATIONAL WILDLIFE FEDERATION. *A Desert In Your Own Backyard.* Washington, D. C. (232 Carroll Street, N.W.): National Wildlife Federation. 16 P. Free.

This pamphlet through brief textual material and illustrations demonstrates the vital need for soil conservation practices in the United States. It defines "Your Own Backyard" as the "good old U. S. A."

Brief references are made to the need for forest, wildlife, soil and water conservation. There is an excellent U. S. soil erosion map. Since 1776, it is estimated we have lost three inches of our then nine inches of top soil. Fifty million acres have been completely destroyed by erosion. This is an excellent pamphlet for every teacher and every American. It is excellent resource material for the conservation unit in science.

BILES, ROY E. *The Complete Book of Garden Magic.* Chicago: J. G. Ferguson, Publisher, 1953. 334 P.

The Complete Book of Garden Magic is an unusual publication. It will be of interest and of much practical value to all persons interested in having better and more beautiful gardens.

It tells you the right way and the best way to get the most out of everything from the simplest house plant to a complete outdoor garden. Making beautiful yards or gardens is a leisure time hobby of many individuals. The book is based on the long experiences of the author, one of America's better known gardeners.

Seemingly, practically every aspect of gardening is discussed: planning, soil fertility and how to maintain it, lawns and grading, trees and shrubs, planting, transplanting, pruning, coniferous evergreens, acid loving plants, hedges, vines, the flower garden, roses, bulbs, corms and tubers, the rock garden, the water garden, the vegetable garden, fruits and berries, plant diseases and pests, equipment, propagation, the amateur green house, window boxes, house plants, soilless gardening, garden construction, garden records, flower arrangement, and calendar of garden operations.

There are many illustrations and charts. There are detailed descriptions and specific recommendations regarding plants, and numerous other features making this a fine book for any person—man or woman interested in having a more beautiful yard or garden.

TAYLOR, NORMAN. *The Permanent Garden.* New York: D. Van Nostrand Company, 1953. 128 P. $2.00.

The Permanent Garden is one of a series of small and inexpensive garden guides to enable the home owner with property of any size, large or small, to have an attractive and permanent setting for a house throughout the year using only trees, shrubs, and vines that require a minimum of maintenance expense and care. Various sizes and types of lots are considered. Suggestions are specific and practical. The reader is supplied the kind of information he needs and desires. Anyone planning on changing their yard shrubbery or starting their yard shrubbery will find this book exactly what they are looking for.

Chapters are: The Garden Frame; Accents and Vistas; The Small Place; Trees for Shade, Color, and Fragrance; Evergreens for Winter Effects; and Planting and Moving Shrubs and Trees.

The book will serve as an excellent reference for biology students and teachers.

TAYLOR, NORMAN. *Color In The Garden.* New York: D. Van Nostrand Company, 1953. 117 P. $2.00.

Color In The Garden is designed to enable the home owner to plan and produce a garden, or sections of a garden, utilizing the predominant color of his choice—red, blue, yellow, pink, white, green, gray and lavender—and to have continuous bloom throughout the growing season. Six simple plans in detail are included, showing exacly what flowers to use and the relative positions of each. Detailed information is given in the textual material about each flower suggested. A chapter is devoted to each color of flower. Description and information is specific and sufficiently detailed to be most useful for one interested in planting garden flowers. The book would serve as a fine reference, too, for biology students and teachers.

PETTINGILL, JR., OLIN SEWALL. *A Guide to Bird Finding West of the Mississippi.* New York (114 Fifth Avenue): Oxford University Press, 1953. 709 P. $6.00.

The author's earlier *A Guide to Bird Finding East of the Mississippi* was acclaimed by bird authorities as about the best book ever published on bird watching. Undoubtedly this book is equally good. It is an effective guide to where and how to find the characteristic birds of any region west of the Mississippi. Clear instructions, keyed to road maps and their route numbers, are given for reaching good bird-watching spots. The author points out the best vantage point for observation, special equipment that may be needed, the best overnight accommodations nearby, and even where to park the car!

For each location the book lists the species that may be found and when they are likely to be plentiful. It describes cover such as bushes, sandy beaches, treeless mountain tops, and so on. Special attention is devoted to metropolitan areas and vacation centers, breeding colonies, and winter aggregations.

Each of the twenty-two western states are discussed in alphabetical order and in much detail. This book should be especially valuable for all teachers, students, and laymen living west of the Mississippi who may be at all interested in bird watching. Biology, general science, and elementary science teachers will find the book especially helpful.

LEOPOLD, LUNA B. *Round River.* New York (114 Fifth Avenue): Oxford University Press, 1953. 173 P. $3.00.

Round River is excerpts from the unpublished journals and essays of Aldo Leopold. It is a record of reflections and observations on nature by a man who loved it and lived it. Some readers will recall Aldo Leopold's writings in *A Sand Country Almanac, Report On a Game Survey of the North Central States,* and *Game Management.*

A short biographical sketch of Aldo Leopold appears in the October, 1953, issue of *Nature Magazine* where he is listed as one of America's ten most influential men in conservation. This list of ten was selected by a committee of forty-two authorities in the field of conservation. Dr. Leopold was a professor at the University of Wisconsin for many years. His definition of conservation is regarded as a classic.

"Conservation is a state of harmony between men and land. By land is meant all the things on, over, or in the earth. Harmony with land is like harmony with a friend; you cannot cherish

his right hand and chop off his left—the land is one organism."

The daily entries in his journals were written in camp on his many field trips—hunting, fishing, exploring. Entries in these journals were made while on trips in Canada, Mexico, and Colorado. The author is the son who edited his father's journal entries. There are illustrations by Charles W. Schwartz.

Round River is described as a book for any conservation enthusiasts and others who would share the mood of Izaak Walton when he wrote, "I have laid aside business and gone-a-fishing."

Childe, V. Gordon. *What Is History?* Clarke, Grahame, *From Savagery to Civilization;* Walbank, Frank W. *The Decline of the Roman Empire in the West;* Gibbs, Marion. *Feudal Order;* Childe, V. Gordon. *Social Evolution.* New York (20 East 70th Street): Henry Schuman, Inc., 1953. 86 P.; 116 P.; 97 P.; 147 P.; and 184 P. $1.00 each.

The above five titles are the first of a series of *Shuman's College Paper Backs* selling at a dollar each. Leading American and British scholars collaborated in writing this brief historical studies series. They are authoritative, very readable, concise, and well illustrated. Quite a bit of science, especially archeology is interwoven in the series.

What Is History is a rapid review of the changing conceptions of history which have characterized past epochs.

From Savagery to Civilization shows man's increasing control over nature and follows the story of his development till the first dawn of civilization, when man came to live together in villages. One interesting chart illustrates the briefness of civilization in man's total history. It estimates that it is five generations to the Battle of Waterloo, thirty-five generations to the Norman Conquest, eighty generations to the birth of Christ, two hundred generations to the First Dynasties, 280 generations to the first farmers, and 20,000 generations to the first hominids.

The Decline of the Roman Empire in the West re-examines the many different reasons that have been advanced for the failure of the Roman Empire to maintain its domination over Western Europe.

Feudal Order discusses the social order and civilization known as the Feudal Order which came into existence after the fifth century in Western Europe.

Social Evolution is a story of man's evolution in time estimated archeological evidence that reflects the culture institutions, customs, and behavior of the prehistoric inhabitants of Europe, the Mediterranean, and Mesopotamia. The author indicates the difference between biological and social evolution and examines illiterate societies in the light of historical relics.

Altogether this series will give the general reader a broad sweep of man's development. The content is based to a large degree on archeological findings of the last fifty years.

Peattie, Rod and Lisa. *The Law: What It Is and How It Works.* New York: Henry Schuman, Inc., 1952. 146 p. $2.50.

Peculiarly enough very few popular books relating to law are available to laymen or teenagers. Such a book as this should fill a real need. It gives quite a different slant in looking at the law from its treatment in textbooks, newspapers, magazines, radio, actual contact, or hearsay. The reading of books such as this should be most helpful in giving youngsters (and adults, too) a more correct, intelligent idea of what actually constitutes the law, how it operates in different societies, and how it operates in our daily lives. Every minute of our lives we are affected by the law in one way or another.

It is very important that teen-agers have correct ideas of and right attitudes toward laws. Here is an excellent book that will be of great value in doing this. The reviewer highly recommends this book for teen-agers and for the high school library.

Adams, George Worthington. *Doctors in Blue.* New York (20 East 70th Street): Henry Schuman, Inc. 1952. 253 p. $4.00.

Doctors In Blue is a medical history of the Union Army in the Civil War. The material in this book was first presented as a doctoral presentation in history at Harvard University.

It is a most readable account of a phase of war not too often considered when assaying the operation and effects of the Civil War. It gives an interesting insight into the health, medical, sanitation, and hospital practices of ninety years ago.

In the Civil War some 300,000 Union soldiers lost their lives. Disease accounts for about 200,000 of these deaths and death from wounds in battle about 100,000. There were 400,000 cases of wounds and injuries and almost 6,000,000 cases of sickness. Startling as these figures are, it was a great improvement over the Mexican War when 10 men died of disease from every one killed in battle. Confederate figures were much less.

The author concludes that the medical and sanitary record of the Civil War was on the whole a good one, the Civil War taking place at the end of the medical "middle ages" immediately before bacteriology and asceptic surgery made their entry. Women nurses in the Army first came into existence.

Science teachers as well as history teachers and lay readers in general should find this a most interesting book to read. Based on extensive research, it is the finest, most authoritative book that has been written about an important activity of American life during one of

its never-to-be forgotten periods. Only one of these Union veterans are now living. Time marches on!

HOLISHER, DESIDER AND BECHEL, GRAHAM. *Capitol Hill.* New York: Henry Schuman, Inc., 1952. 143 p. $3.00.

Capitol Hill is the story of Congress in text and pictures. There are one hundred photographs especially taken for this book by Desider Holisher. You will find one of these excellent photographs almost on every page. The textual material traces the past and present history of Congress. It gives a lively story of the bustle and hustle, the splendor of the most important law-making body in the world.

Congress is pictured as a truly human institution—a body of men and women, surrounded by much symbolism and circumscribed by much tradition.

Readers will learn many interesting things about the Capitol building, its paintings and statues, historical documents, important rooms, the legislators in action, the process of law making, and the busy lives of people who make the wheels of Congress turn. The chapter on paintings and sculpture in the capitol building is most interesting. This is a book that should be in every junior and senior high school library and read by all boys and girls in those schools. Adults will also find it a book that should give them a real thrill of pride as Americans in having a Capitol and Congress so ornate in design, so rich in tradition, and so encompassed with the hopes and aspirations of tomorrow.

BRINDZE, RUTH. *The Story of the Totem Pole.* New York: The Vanguard Press, Inc., 1951. 64 p.

Indians of the Northwest had a wonderful way of recording their stories: they carved them on cedar poles. These decorated trees—totem poles we call them—were carved with strange and beautiful figures representing real people, animals, birds and fish, as well as imaginary creatures, and each one illustrates some story or part of a story. Skilled workers carved the stories on poles. Soon after the white man came to the Northwest, the Indians ceased making totem poles. Many totem poles had partially or wholly disintegrated before their true historical value was realized. Recently both the Canadian and United States governments have established especial training courses where Indian artist can learn totem-pole carving. Some of the new poles are copies of old ones and others are completely new.

A number of Indian stories carved on totem poles are related by the author, including the famous Abraham Lincoln Totem Pole. Illustrations in black and white, and color by Yeffe Kimball add much to the attractiveness of the book. Mr. Kimball, born in Oklahoma and of Indian origin, is a recognized authority on Indian art.

BRINDZE, RUTH. *The Story of Our Calendar.* New York: The Vanguard Press, Inc. 64 p.

Most people are interested in the calendar and how it came to be. This book tells all about the origins and development of our Gregorian Calendar. The author makes this historical development a fascinating story. All sorts of questions people often want to know about the calendar are answered in this beautifully illustrated book. The illustrations are by Helen Carter.

Of continuing interest and up-to-dateness through the years, this book takes on added interest and significance because of the agitation for the possibility of our having a World Calendar in 1956. About the only obstacle to there being a new calendar at that time is the inertia of people to change, although there is every scientific reason for making the change.

Printed on the inside jacket cover is a Long-Time Calendar which enables a person to find the week day of a given date from 1800 through 2000.

For a brief, authentic, interestingly told story of our calendar this book is most highly recommended. It will be a valued addition to the science book shelf.

JAEGER, ELLSWORTH. *Woodsmoke.* New York: The Macmillan Company, 1953. 228 p. $2.95.

The author himself describes *Woodsmoke* as "a book of outdoor Indian lore—a book that shows step by step the how-to-do crafts and skills needed in making folks comfortable out of doors. Both winter and summer is taken into consideration in this book as well as East and West."

The book is full of short-cut tips and sound advice as to ways and means of outdoor cooking, medicinal aids, keeping yourself and things warm or cool, safe and dry. Sections cover shelter, equipment, stalking, luring and calling animals, and such lore as to how to tell temperature without a thermometer, the height of trees without a tool for measuring, and so on. There are almost 130 full page drawings by the author to clearly illustrate the directions in the texts. These drawings are indeed very interesting and would make an excellent book in themselves. Indian folklore and anecdotes enliven the book.

Woodsmoke is not only a book for those living out of doors or planning to live out of doors either frequently or occasionally but is also an excellent book for the science book shelf. Elementary science, general science, and biology teachers will find in this book a wealth of accurate information for classroom use.

Mr. Jaeger has been a member of the faculty of the Buffalo Museum of Science since it opened in 1929. Since 1951 he has presented a nature television program over WBEN-TV.

He also is a traveler and writer of note. His *Wildwood Wisdom* has been exceedingly popular and his other books are unusually interesting: *Nature Crafts, Tracks and Trailcraft, Easy Crafts,* and *Council Fires.*

Williams, Charles Kingsley. *The New Testament.* New York (55 Fifth Avenue): Longmans, Green and Company, 1952. 545 P. $2.25.

This is a new translation of the New Testament especially intended for children. It is believed that children in the grades can read this translation and that it can be understood by a child of six or seven years of age. The author is a noted Bible authority and translator. About 1,500 fundamental words of everyday speech are used. The style is pleasing, direct, clear, reverent. It reads quite differently from that of the King James version. It should prove much more readable and understandable to children. Parents and teachers of religious education for children will find this a more understandable and interesting translation for children. Short sentences and common words have been used. There is a glossary and twenty-one pages of notes.

Toulmin, Stephen. *The Philosophy of Science.* New York (55 Fifth Avenue): Longman's Green and Company, Inc., 1953. 176 P. $2.40.

This is an introduction to the philosophy of science by Dr. Toulmin, Lecturer in the Philosophy of Science at the University of Oxford, England. The author attempts to indicate the steps by which the transition from common sense to science proceeds: the function of "explanations", the place of mathematical methods, the characteristic roles, theories, hypotheses, and "laws of nature." The author points out that many great scientists in writing of the exact sciences in attempts to make the exact sciences more understandable, only succeed in adding to the confusion. The author points out that such great scientists as Eddington and Jeans were guilty at times in this regard.

Morris, Lloyd and Smith, Kendall. *Ceiling Unlimited.* New York: The Macmillan Company, 1953. 417 P. $6.50.

Ceiling Unlimited is the story of American aviation from Kitty Hawk to supersonics—from 1903 to 1953. Undreamed of progress has been made in this half-century. Few others, if any, inventions of man has made as comparable progress in as brief a period. An age-old dream of man-kind became a promising reality on cold December 17, 1903 on the lonely sand dunes of Kitty Hawk, North Carolina. Here Orville and Wilbur Wright got a rickety mortorized flying machine aloft and in 12 seconds the first powered flight had covered a distance of 120 feet.

This book, written to honor the 50th Anniversary of Powered Flight, traces the history and development of flying. Progress was slow and discouraging at first. But in retrospect it was really much more rapid than developments in other inventions. The author traces the steps of development, more or less chronologically. As the developments were closely interwoven with the lives of men and women who risked and often gave their lives in the undertaking, the story is unfolded as a saga of one of man's greatest accomplishments. Truly a heroic and thrilling story it is and vividly told by the writers who write unusually well. Many photographs supplement the material. The photographs of the first and earlier planes are visual evidences of the real progress that has been made. Developments came rapidly during World War I. Lindbergh's flight in 1927 added fire to the interest in aviation, especially commercial aviation. World War II speeded aviation development and advance has been rapid in the post war period.

This is an unusually fine book on the development of aviation—free from technicalities. Boys and laymen will read the book enthusiastically. It is an excellent source book on American aviation and is highly recommended for the high school library.

Wiener, Norbert. *Ex-Prodigy: My Childhood and Youth.* New York: Simon and Schuster, 1953. 309 P. $3.95.

Norbert Wiener is known today as one of America's leading scientists. Many associate his name with the word "Cybernetics"—a science dealing with communications in both man and machines. The program of this science was first published in a book in 1948 also entitled *Cybernetics.* Later in 1950 Wiener wrote a book called *The Human Use of Human Beings.* But in his youth Wiener was known as a child prodigy. Born in Columbia, Missouri, November 26, 1894, young Wiener graduated from Ayer, Massachusetts, High School. At the age of 11 he entered Tufts College, graduating in 1909. He did graduate work at Cornell University, then entered Harvard University, obtaining his Doctor's degree in Philosophy at the age of 18. Wiener had unusual ability in mathematics, zoology, languages, and philosophy.

Dr. Wiener's father was Harvard's first professor of Slavonic Languages and an authority in philology. He was something of a prodigy himself—an adult prodigy of learning. He was an emigrant, first coming to New Orleans, wandered through the South and Midwest, taught in the Kansas City High School and the University of Missouri where Norbert was born. He brought up Norbert deliberately to develop a naturally good mind as thoroughly and comprehensively as possible. The boy grew up to honor, love, and fear his father—a complex of emotions that left its mark permanently.

Dr. Wiener traces the story of his life objectively, in detail, and most interestingly. He evidences the fact that he has a most wonderful memory, for this story of his early life, replete

in details, was largely dictated. All of his emotions, reactions, and remembrances are seemingly set down, without any inhibitions, whatsoever. He makes many interesting comments upon his home life, his social life, and life as a student, his teachers and professors, the colleges he attended, his courtship, and so on. Strange as it may seem it was only in late adolescence he realized he was a Jew. The effect of this discovery, the effect of his early ignorance, and the effect of his inheritance in later life, constitute an important aspect of his life.

In the early days, he had a rather difficult time vocationally. At first he had his problems as a college teacher. Later he had turns as a hack writer, a newspaper man, and as a soldier in World War I. For the last 33 years he has served as a professor of Mathematics at Massachusetts Institute of Technology.

Altogether this is a delightfully told, interestingly written book by a child-prodigy as he recalls his earlier life.

SYMPOSIUM. *Ford at Fifty.* New York: Simon and Schuster, Inc., 1953. 108 P. $2.75.

The word Ford is one of a list of very few words that truly symbolize America. Very few Americans will not know what Ford means. While the meaning will vary to some degree it means transportation, an automobile, an American revolution in travel, labor-capital relations, mass production, assembly-lines, opportunities offered in a free-enterprise system, and so on.

This year Ford celebrates its fiftieth anniversary of Ford cars. This book largely in pictures traces the fifty years of progress and development of American industry in general. Both pictorially and historically this is a most interesting book. It supplements the interesting Ford article in Life magazine of May 25, 1953. Yes, Henry Ford was a truly great American and his grandsons Henry II, Benson, and William Clay have carried on the Ford tradition in an expansion that Henry would have been truly proud of. Altogether this book is outstanding, tracing as it does the development of a typically American industry, with an emphasis upon present activities.

KUGELMESS, J. ALVIN. *Ralph J. Bunche: Fighter for Peace.* New York: Julian Messner, Inc. 1953. 174 P. $2.75.

Readers may recall the author's earlier: *Louis Braille: Windows for the Blind* as an unusually well written biography. This first biography about Ralph J. Bunche is equally well done.

The life of Dr. Ralph J. Bunche is understandingly, sympathetically told. The earlier days of Ralph J. Bunche were quite reminiscent of those of that outstanding scientist, George Washington Carver. Born in Detroit, Bunche was the grandson of Ralph Johnson a former slave. Ralph's father Fred, was a barber who made a very meager living. Young Ralph Johnson Bunche showed great promise in his early elementary schooling, handicapped as the family was by lack of financial security. The family thought to improve their circumstances by moving to Toledo. But conditions and the health of his parents became worse and the family moved to Albuquerque, New Mexico. Here at the age of fourteen Ralph was orphaned. During the earlier years and for many years after Ralph's parents died, Grandma Johnson was the guiding hand. Grandma Johnson seems to have been a remarkable woman and greatly influenced young Ralph in getting an education. The family moved to Los Angeles and here by hard work, frugal living, and the inspiration of Grandma Johnson young Ralph graduated from elementary schools, highschool, and the University of California at Los Angeles. A fellowship at Harvard University enabled him to obtain a master's degree in political science. Then he obtained a teaching position at Howard University in Washington, D. C., where he met Ruth, a grade school teacher, who became his wife. Soon he completed his Ph.D. degree at Harvard. The government soon recognized his unusual abilities and made numerous calls upon his talents. He was the first Negro in American history to take over a desk in the State Department. His greatest achievement has been his work as a United Nations mediator in bringing about a peace between the Arabs and Jews. He deservedly won the Nobel Peace Prize in 1950. A staunch believer in the worthwhileness of the United Nations he is now principal Director of the Department of Trusteeship and Information for Non-Self Governing Territory of the United Nations Secretariat. A winner of many honors and degrees, a world renown American, Grandma Johnson would have been even more proud of her boy, Ralph, had she known.

DUBLIN, LOUIS I. *The Facts of Life.* New York: The Macmillan Company, 1951. 461 P. $4.95.

The Facts of Life is the result of many years of research performed by the statistical staff of the Metropolitan Life Insurance Company under the direction of the author, Dr. Dublin. In this book the author attempts to answer the hundreds of thousands of questions asked by the public about various aspects of American living. This book has compiled, segregated, and tabulated those questions into a book of lasting value.

There are twenty-five chapters dealing with such problems as Who We Are, The Pattern of Reproduction, The Pattern of Marriage, Mortality in General, The Conquest of Tuberculosis, The Control of Cancer, Our Old People, The Accident Toll, Suicide and Homicide, Mental Health, How Long We Live, and so on.

Each chapter is made up of a series of related questions and their answers. For example:

What is the population of the world? How many "war brides" were there? What proportion of married women remain childless? Are the more educated people less likely to marry? What proportion of wives work? How do the states rank as to mortality? Are more women than men killed in home accidents? What do heart murmurs signify? and so on.

The Facts of Life is a convenient and useful reference book for science teachers and teachers in general, health workers, social workers, research workers, and so on. It is the first publication of its kind and is based upon as accurate information as can be found.

Longstreth, T. Morris. *Understanding the Weather.* New York: The Macmillan Company, 1953. 118 p. $2.50.

Understanding the Weather is a revision of the author's earlier *Knowing the Weather* which was preceded by his *Reading the Weather.* This latest book describes developments in the science of weather within the past ten years and is a culmination of the author's lifetime interest in weather phenomena. This is a book for the general reader and is devoid of undue technical vocabulary.

There are chapters on the atmosphere, air-masses, fronts, cyclones, wind, temperature, clouds, man-made rain, thunderstorms, snow, hurricanes, tornadoes, weather maps, forecasting, climate, weather tools for the amateur, and weather records.

Elementary science teachers, general science teachers, and laymen will find this an interesting book on the much discussed topic *Weather.*

With a little patience the reader may become a fairly good amateur weather forecaster. Suggestions are found in this easy to read treatise on weather.

Hylander, Clarence J. *Trees and Trails.* New York: The Macmillan Company, 1953. 237 p. $3.00.

This is the second in a series of books by Hylander under the general heading *For Young Naturalists.* The author is eminently qualified to write such a series as he is one of America's best writers of popular science material.

Trees and Trails is a readable plant geography which gives young naturalists a broad picture of varied tree communities from coast to coast. The author describes the life history of a tree and describes the identifying features for over 150 different trees. He places special emphasis upon how the special characteristics of different trees suit the environment in which they live. If this sounds sort of textbooky, it definitely is not that sort of a book at all. Hundreds of illustrations and photographs in black and white supplement the textual material. Black and white drawings of leaves, flowers, and fruit add to the ease of identification.

This is an excellent reference for the elementary science, general science, and biology teacher and for the science library. It also serves as an unusually fine book for the lay reader.

Denman, Frank. *Television, the Magic Window.* New York: The Macmillan Company, 1952. 60 p. $2.00.

This book attempts to explain in simple terms how television works. The author briefly traces the history of television from its early beginnings. Enough technical detail is included so that boys and girls and laymen will have a fairly good general idea of how television works—from the theory behind it to the putting on of television programs and their later reception on home television sets. Many photographs and illustrations aid in understanding the descriptive material.

The author is an advertising man and not a scientist. Hence he writes in terms a layman is most likely to comprehend. The book should sufficiently satisfy the curiosity of most junior and senior high school students and it is a good book to begin with for those individuals wishing to pursue the study more intensely.

Lent, Henry B. *From Trees to Paper.* New York: The Macmillan Company, 1952. 149 p. $2.75.

From Trees to Paper is the story of newsprint. The author traveled to Baie Cameau, Quebec, to obtain the story. Here on the north shore of the St. Lawrence River are thousands of square miles of virgin forest, mostly spruce and balsam. A few years ago a group of men leased this area from the Canadian government and started one of the most interesting enterprises one is likely to read about—carving out of the forest a new city, a large-scaled industry, and one of the biggest paper mills in the world. Mr. Lent spent a month in this Quebec North Woods country, traveling all over the area by jeep, plane, boat, dog teams. Every operation from building roads, homes, cutting the four foot long logs, to the arrival of the finished newsprint in New York City is described.

Mr. Lent has written a fascinating book in a vivid literary style. Numerous photographs supplement the reading material. It is believed this area can furnish newsprint continuously and without the usual reseeding—nature does this herself. As one area is used up, the lumberjacks move on to the next and it is thought certain by the time the last area has been utilized the first one will be ready again and so on. The trees are cut in the winter-time and floated on streams and by flume to the paper mill in the summer time. Some 3,000 or more lumberjacks cut the trees into logs and then work in transportation in the summer. Even feeding the lumberjacks is a gigantic task! For example, one camp uses annually 291,000 pounds of beef, 218,000 pounds of pork, 52,000 pounds of beans, 167,000 pounds of

sugar, 2,200 barrels of flour, 13,000 bags of potatoes, 7,500 cans of baking powder, and so on. Some 450 horses need 1,500 tons of hay and 22,000 bags of oats. All of this has to be brought in by boat during the summer season. Both mechanical and sulphite processes are used in converting the wood into newsprint. The final newsprint paper is about 85 per cent mechanical pulp and 15 per cent sulphite pulp.

This is an excellent reference book for the science book shelf.

Junior and senior high school students will find this a most readable book. Mr. Lent is the author of numerous other interesting books, a number in the science field: *Fly It Away, Clear Track Ahead, Diggers and Builders, O.K. for Drive-Away, Grindstone Farm,* and so on.

SPERRY, ARMSTRONG. *Thunder Country.* New York: The Macmillan Company, 1952. 150 p. $2.75.

Chad Powell accompanies his father on an ornithology trip for rare birds into the jungles of Venezuela—"Thunder Country." Deep jungle with creeping and crawling wild life—strange, suspicious Indian headhunters—unreliable guides —an unexpected plane crash—hostile head chief Kaseek—combine to make this a thrilling, spine-tingling story of adventure for teen-age youth, especially boys. The birdhunt is combined with a manhunt, too, as they search for an engineer who had disappeared earlier. Some readers will recall the author's earlier *The Rain Forest* and *Call It Courage.*

LEYSON, CAPTAIN BURR W. *More Modern Wonders and How They Work.* New York: E. P. Dutton and Company, Inc., 1952. 192 p. $3.50.

Following the author's earlier *Modern Wonders and How They Work* this new *More Modern Wonders and How They Work* describes the following modern wonders and how they work: the modern rifle, rifle ammunition, the shotgun, sporting ammunition, the semi-automatic target pistol, "Carbine" Williams' Floating Chamber, the revolver, locks and locking devices, "atomic" powered submarines and aircraft development of "atomic" power, UHF—what it means to television and to you, how it works in bringing broadcasts into the home, the hydraulic transmissions for automobiles, weather instruments, and the phonograph record. The textual material is illustrated with photographs and illustrations.

Boys of junior-senior high school age will especially enjoy reading this book. Complicated mechanical operations have been simply described. *More Modern Wonders and How They Work* would be an excellent addition to the science book shelf. Other books by Captain Leyson include *Modern Wonders and How They Work, Atomic Energy in War and Peace, Elements of Mechanics, Photographic Occupations, It Works Like This, Plastics in the World of Tomorrow,* and so on.

THROM, EDWARD L. (Editor). *Fifty Years of Popular Mechanics.* New York: Simon and Schuster, 1952. 308 p. $5.00.

For fifty years *Popular Mechanics* has reported the mechanical and scientific achievements of the most fabulous half-century in human history. This book is a selection of some 300 pages, reproduced in facsimile, issues which have appeared in the 660-odd issues since January, 1902. Marginal comments accompanying each page give it perspective in the light of today's knowledge. It is a sort of picture history of the inventiveness that has lifted our civilization from the horse and buggy age to the atomic age. There are picture stories of many of our important inventions and scientific developments. There are also a series of long feature articles by outstanding persons of the first half of the twentieth century.

This is a story of accomplishment in science and invention in which Americans can feel justifiably proud. It is a most highly recommended book for the science book shelf. It is a book that will hold the attention and interest of practically every teen-age boy, and most adults, too.

RIEDMAN, SARAH R. *Grass: Our Greatest Crop.* New York (19 East 47th Street): Thomas Nelson & Sons, 1952. 128 p. $3.00.

Grass is another excellent book for young people by Dr. Riedman, Professor of Biology at Brooklyn, College.

Grass is truly our greatest crop as the story is so well told in this book. It is the indirect source of most of our food. Without grass starvation would almost immediately face the human race. The earth itself would soon be largely an eroded dust bowl. Grasses include a great many different varieties such as corn, wheat, barley, millet, rice, sorghum, bamboo, rye, cane, and all the plants commonly recognized as grasses of one variety or another. Fossils indicate that grasses first appeared about 20 million years ago, each of the large land masses contributing some important and unique variety. Grass not only serves as food for animals but for clothing, hats, jewelry, shelter, drugs, and so on.

This is an excellent reference book for the junior high school student, the science library, and elementary science, general science and biology teachers. Many important principles in science and conservation are emphasized. The story of *Grass* is most interestingly and authoritatively told. Illustrations by Glen Rounds add to the pleasing appearance and interest of the descriptive material.